AGRICULTURAL ENGINEERING

The Journal of the American Society of Agricultural Engineers

MAY 1934

VOL 15 NO 5

A.S.A.E. Annual Meeting . . Detroit, Michigan, June 18 to 20, 1934

ne
c-
his
as

ne
d,
ir
ve
to
ng
rn
of
d.
ol-
d.
be
ne
n't

ay
ts
n-
r-
er,
er-
no
It
e.
is
e-

AGRICULTURAL ENGINEERING

Published by the AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS, Saint Joseph, Michigan

Publication Office at Benton Harbor, Michigan — Editorial and Advertising Departments at Saint Joseph, Michigan

ARTHUR HUNTINGTON, *President* — RAYMOND OLNEY, *Secretary-Treasurer*

VOLUME 15 — MAY 1934 — NUMBER 5

CONTENTS

Subscription price to non-members of the Society, $3.00 a year, 30 cents a copy; to members of the Society, $2.00 a year. Postage to countries to which second-class rates do not apply, $1.00 additional. Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921. The title AGRICULTURAL ENGINEERING is registered in the U. S. Patent Office.

The Engineer as Counsel for the People[1]

By Arthur Huntington[2]

President, American Society of Agricultural Engineers

IT HAS COME to be a practice by good people to make New Year's resolutions. If we are honest in making up our list, we must of necessity take a more or less pessimistic survey of the past, not with the view of scolding ourselves, but in order that we may properly evaluate our greatest needs.

I want briefly to call to mind some of the outstanding happenings of recent years and, without attempting to scold, suggest two of the most glaring defects, not only of agricultural engineers, but of all engineers; defects which the developments of the times have set out in bold relief.

Before I go further let me impress upon you that whether we approve of what is taking place or not means little. The period of change is here. The future depends upon our ability to cling to fundamentals, to salvage from the old that which has been good and to appraise and accept from the new that which is valuable. The knowledge that out of such periods have come the greatest progress, must make optimists of us all.

The period from 1929 to 1933 has been one of economic distress, public hysteria, and political upheaval, not only in this country but throughout the world.

How are we as engineers reacting to the change? Are we using our knowledge of efficiency and our ability to analyze to gain leadership or are we simply following? When we remember that the engineers rushed to prepare a code which placed their professional men on a common plane with artizans and workmen, and coldly analyze the facts, it would indicate that the engineer is falling short, and that he is not only failing in his leadership, but that he is lending his services to politicians, promoters, propagandists, leaders in hysteria, and even to some who counsel destruction.

History shows that there are two vastly different economic cycles working at once; one a short-range cycle which extends over a few decades, the other a cycle which measures its life in centuries. Most people live through one of these short periods, or through enough of two periods to make one complete cycle. Seldom in history has one generation experienced two complete cycles, with the result that each such period is regarded by the people who pass through it as being peculiar to them, and the most severe of all history. So similar are these cycles and so regular in their occurrence, that it would seem as though they followed some natural law. The history of one of these cycles is roughly the history of all of the cycles of any particular period.

The American people as a nation, have passed through four such cycles. Much of their preeminence has come from their ability to weather such cycles and recover. History records similar cycles, as early as the 22nd century B.C. and each major civilization has left records of cycles similar to the one through which we are now passing, and records of efforts at recovery which read like pages from current history.

In addition to these relatively short cycles, there are long cycles which are the results of basic world changes. The opening or closing of frontiers, changes in basic trade routes, inventions which basicly affect large groups of people, long cycle changes in business practices, in fact all basic changes, are factors in these long economic cycles.

The long-range changes affect the short cycles, and sudden changes are often quite disturbing and may be the primary cause of one of the short cycles. The world in general, and America in particular, is now feeling the effect of readjustment, which is the culmination of both long and short-range cycles.

Why are we as engineers interested in these great economic changes, whether the long-range change or the short cycle, or governmental expenditures? The answer is simple; we have been a factor in nearly all of them; we have been the beneficiary or victim, depending on whether the cycle is in flood or ebb. We are interested because there has come a time when we must adjust ourselves to the cumulative effect of several basic long and short economic change cycles, and the inevitable public works programs which have developed as the culmination of the present cycles. As agricultural engineers, we are particularly interested in several of these basic problems. In the last few decades a frontier, open for nearly three centuries, closed as the last free land was homesteaded.

The making of equipment ceased to be the work of artizan and became a manufacturing problem; many men have been replaced with automatic equipment.

Production per agricultural worker has increased enormously. Man-hours in production became almost man-minutes in less than 75 years.

By our efforts, new lands and new ways of handling marginal lands have been developed.

[1]An address before a meeting of the Southern Section of the American Society of Agricultural Engineers at Memphis, Tennessee, January 31 to February 2, 1934. Abridged.

[2]Public relations engineer, Iowa Electric Light and Power Company. Mem. A.S.A.E.

The drift of population was from the farm to the city, and is now from the city back to the farm.

These production activities grew to vast proportions without our once realizing that we must eventually become a creditor nation and that increased production must be absorbed by increased standards of living, whether the new product is consumed at home or sold abroad. Suddenly America became a creditor nation as well as a surplus producer nation.

For many decades we bought our international exchange with our surplus agricultural produce. Due to better sales practices of the American manufacturer, we are now buying this exchange with products of the factories. Much of our agricultural distress is the result of this change. Agriculture has not yet awakened to the fact that her competitor is not foreign agriculture, but the American manufacturer competing for the privilege of purchasing our foreign exchange.

How Has the Engineer Reacted to the Recent Great Basic Change in National Policy?

For many years business men, speculators, and agriculturalists fairly drove our political leaders into extending the frontier with irrigation and drainage projects, many times at the expense of public credit, and more often by creating submarginal farm enterprises. These demands for land extensions were paralleled by similar demands for governmental entry into the field of private business. Engineers and manufacturers at the same time were busy creating changes which outstripped the ability of the people to keep pace with development.

All of these basic changes came to a climax at a time of economic readjustment and when the public was in panic. There came into a power a political administration which had almost unlimited patronage to dispense, and a large majority in both houses of Congress. Facing it was great unemployment, coupled with unlimited resources in our banks looking for some security safer than ordinary business and fluctuating property values. The result is almost a fanatical public insistence for public works programs and governmental entry into the field of private business.

How has the engineer reacted to this great basic change in our national policy? To date there has not been a business, political, promotional, or socialistic scheme proposed that has not had the endorsement of some engineer, of more or less renown, and there have been few engineers who have raised their voices in protest. The fact that many of these public works programs have been branded as promotional, submarginal, and unnecessary seems to be of little moment. The engineer has not even mentioned the fact that many of these projects are based on popular prejudices rather than sound economic engineering.

As professional engineers we will not discuss the right of the government to enter business. Such governmental activities may be neither economic or ethical, but they are without question legal. As citizens we may associate subsistence farms, whether they be at Dearborn, Michigan, or on some government-financed irrigation project, with Markham's "man with a hoe." As engineers we must view them with all factors dragged out in the open; we are even charged with the responsibility of balancing the engineering facts with the economic and civic values.

I could spend much time analyzing any one of a large number of projects, both public and private, which never would have seen the light of day, had there been honest engineering reports. Let us first look at the public projects, using only examples which are old enough to be beyond the present political era.

They would run all the way from the Hennepin Canal which was so long in building that the American people forgot its very existence, to say nothing of the alleged need, to a whole flock of inland waterway projects which will have little more economic value than did the Hennepin Canal. The fact that the New York barge canal is a white elephant, or that barges on the Ohio, Tennessee, and Mississippi rivers are receiving subsidies many times the cost of transporting the tonnage by rail, or that the tonnage which these waterways were supposed to haul never did exist, seems never to have been put into any engineering or economic report.

There is not one of these projects that was not in the beginning a political speech, which was vouched for by some engineer and in the end became an alleged economic necessity, built with a tax-free, treasury-guaranteed bond issue and subsidized in its operation by an overtaxed treasury in deficit.

The fact that no hydro plant can ever again hope to compete with a first-class steam plant, when all costs are considered, does not seem to enter into the calculation of promoters, bankers, engineers, laymen, or politicians. Even in times of great unemployment, the fact that hydro plants are built at a maximum of money investment and employ a minimum of operating payrolls does not seem to be worthy of mention. Both water transportation and hydro power have lost out in competition, yet engineers seem to be afraid to make a report which sets out the facts.

Reports on private projects are just as remiss as any public reports. Some years ago there was developed, in one of our western states, a project where there was so little water in the creek (and creek is the right name) that when it came time to mix the cement the water had to be hauled in in tank cars. The project was designed by a good engineering firm and checked by an engineer who has been honored by one of the founder engineering societies. Both excuse themselves on the ground that they thought the promoters knew how much water there was; both claimed that they simply checked the design and stability of the structures.

I recently spent an evening with a group of engineers where the conversation drifted to the necessity for greater integrity in engineering reports and supervision. Two or three examples will illustrate the point.

Some Glaring Examples of Ill-Advised Projects from an Engineering Viewpoint

One man produced an engineering report on one section of the inland waterway, where the traffic must go around a right-angle turn at the rate of 90 miles per hour, if the estimated traffic ever develops. Another referred to the estimated minimum electric consumption on one of our most famous government projects. The rate engineers figured that these subsistence farms will use about six times as much as the national average for such customers. One of our much talked-of hydros is on a river which, in flood, carries as much as 7 per cent sand in suspension and for many months of the year is practically dry. Another is 200 miles from a single power customer.

As an agricultural engineer, I could not help but think of some engineers to whom I will charitably refer as blunderers in our field. I know of a cow barn which cost $6,000 per cow capacity and a hog house where the interest and depreciation costs have been $9.50 per pig sold off the farm over a period of ten years. I know a farm where the building overhead is more than three times the value of the land, yet each of these is a show place.

The ability of our engineers to work submarginal land projects over into power projects of alleged merits is reprehensible, and the pressure put behind political leaders to extend governmental aid to submarginal promotional projects is almost criminal. Less than a month ago the promoters went before the legislature of one of our western states with a project which has been kicked around for more than fifty years. They had an engineering report which showed that the state would make $20,000,000 annual profit from the sale of power at reduced rates. The census figures show that the gross business in the whole region was less than $13,000,000 in 1932.

Why do engineers lend their names to such projects? Why do they accept the leadership and direction of men who simply want to use them at a price—and usually a miserably low one? Why do they as professional men rush to make out a fair-practice code which ranks them as skilled laborers?

The most charitable answer I can give is that they have spent so much time developing equipment and efficient practices that they have neglected such major problems as leadership, economic value of the things which they have made, the apportioning of the benefits of production, and other matters of this nature.

Gentlemen, as engineers we must refuse the use of our names and reputations, unless we are willing to be classed as men willing to sell our talents for a price. I recently heard an engineer say, in addressing the board of directors of the engineering society of his state, "The engineer ought to exert more leadership, but his first duty always has been and always will be to earn a living; if he is to make a living, he of necessity must make the kind of reports his clients want."

This brings me to my first New Year's resolution for engineers.

Engineers should refuse to sell the use of their names. By this I mean that each engineer's report should reflect more the man's appraisal of the value of the project, and be less an endorsement of the promoter's dream. It should reflect him as a professional leader, rather than a skilled workman operating under a code.

You will note that I say reports. For many years the engineer has rendered high-type service as a designer, as a builder, and as an operator. It is only recently that promoters and politicians and bankers and chamber-of-commerce secretaries have seen the value of a first-class engineer's name on their promotional prospectus.

It Is Important for Engineers to Know Both the Economic and Civic Value of Projects

As engineers you must know the economic and civic value of many public and private programs; you must know when they are being promoted in the name of progress and when they are only hazards in disguise. Each of you know that many highly improved farms are simply pieces of land which have been confiscated with alleged improvements. You know that many of the small-home farm projects which have been promoted with the backing of commercial, charitable, and public funds are sentimental, economical, and social hazards. Each engineer should raise up and protest against such practices!

My second resolution is closely akin to the first. I refer to leadership. The engineer must become a larger factor as a man of affairs. Many times as engineers you will have to rise up as citizens, as leaders of public thought, as directors of public activities.

How often have each of you heard of some project being promoted because it has a nuisance value! Some years ago, I spent several months surveying waterpower and electric-railway projects, all of which had commercial backing. For the most part they had no economic or civic value. Had there been a few high-grade men with the courage to speak out what they knew, much money and community prestige would have been saved.

The day of promotional electric railways with only public pride and ignorance to justify their existence is past; but submarginal hydros with even less value are still receiving civic, commercial, and political backing. The fact that they are a part of a made-work program is poor justification. Subsistence farms should receive more analytical study and less ballyhoo.

You know that out of each made-work program will come a new problem to handle. The first pyramid was a made-work program, and out of it came a race of pyramid builders. Our own post-office building and rivers-and-harbors programs were a part of the made-work program of Civil War recovery days, yet today, more than half a century afterward, we have a race of post-office builders to be satisfied and duplicate post offices are being built. Our inland waterways are simply jobs for an overgrown race of rivers-and-harbors builders.

A Challenge to Agricultural Engineers to Assume Greater Leadership in Their Field

Few professional or business groups have contributed so much to the general good, and at the same time have made so little effort to assume leadership. This lack of effort to assume leadership is a particular weakness of the agricultural engineer.

The combined effort of the soils men, the plant breeders, and all agencies of this class have increased the crop yield per acre about ten per cent, whereas the engineers have more than doubled the production per worker. The marketing agencies, including all political contributions, over a long period of years, have not increased prices as much as the engineer has reduced the cost of production. The engineer has unselfishly joined hands with the workers of other groups. Working with the seed experimentor he has been a factor in extending the agricultural land area far beyond anything the politician and promoter, working together, can hope to attain.

We are, whether or not we accept the challenge, charged with the well-being of those who are engaged in and receive the benefit of agriculture. We must not only know the civic and economic value of the projects which are a part of our everyday development; we must know the motive behind each of them. We must be familiar with that part of the short-time business cycle of which we are always a part. We must also try to fit ourselves into the long-range cycle.

Above all, we must have courage as engineers to make honest and complete reports; as citizens we must have the courage to drag into the open those projects which are simply a hook upon which to hang a promotional or political activity, whether it be labelled public improvement, educational, or made-work in the name of charity for some distressed or preferred group. Stated briefly, we must know whether they are for public good or private greed.

If we are honest as engineers and courageous as citizens, our profession will cease to be dragged into questionable projects and in a few years our contribution to the civic and economic world will compare favorably with our position in the world of production.

Gentlemen, I have not printed a rosy picture. I may have slandered the profession by charging it with the shortcomings of a few. No slander is intended. I am just call-

ing to your attention the greatest sin of omission and the major sin of commission as they have appeared in the last few years, and asking you, the solvers of problems in the production world, to protect your names, and, in so doing, protect the names of all engineers:

1 By refusing your names to promotional and non-economic projects

2 By exerting a leadership in the economic and business world, comparable with your leadership in the world of efficient production.

A new economic era, borne out of the mistakes of the past and by a desire for progress, is in the making. Shall we as engineers accept it as hirelings, or shall we assume the role of leadership? As president of the American Society of Agricultural Engineers I have faith in engineers, and unlimited faith in the future.

Agricultural Engineering Curriculum Offered at Illinois

AGRICULTURAL engineering takes its place, along with the other courses of study, in the College of Engineering at the University of Illinois, and students who are interested in agriculture and its allied industries, and who are engineering minded, can now secure a degree in agricultural engineering. While the status of the Department of Agricultural Engineering in the College of Agriculturee has not been changed, the curriculum will be offered in and administered by the College of Engineering through its Dean with the advice of the Head of the Department of Agricultural Engineering of the College of Agriculture.

The first year requirements in agricultural engineering are the same as in other engineering courses. Specialization will begin the second year. Early in the course students will have an opportunity to take work in the Department of Agricultural Engineering and also certain basic courses in the College of Agriculture. The objective of these courses is to give a background and a point of view which will be helpful in giving the student a better appreciation of the field of engineering as applied to agriculture.

Two options are provided in the course: one is a power and machinery option, and the other is a drainage and farm structures option. The student who enrolls in agricultural engineering will have an opportunity to make his choice of one or the other of these two options at the beginning of his junior year. The student who is interested in machinery and power will be given an opportunity to have a thorough training in machine design, while the student who is interested in farm drainage and structures will have an opportunity to study design problems in these fields.

Several students have already enrolled in the technical course in agricultural engineering, and at least two should qualify for their degrees at the end of the current year. During the last ten years there has been an increasing demand for agricultural engineering graduates in the tractor and machinery industry and in rural electrification work. The recent increased activity in soil erosion and flood control work has created a demand for agricultural engineers that has greatly exceeded the supply.

Corrections

A FEW ERRORS occurred in the letter to the editor, entitled "Irrigation Pumping," appearing on pages 142 and 143 of the April 1934 AGRICULTURAL ENGINEERING, as follows:

1 The numerator of the first term in the right-hand member of Equation 18 (page 142) should be "1" instead of "*l*". In the same equation the coefficient of the log of *R* should be "*c*" instead of "*C*".

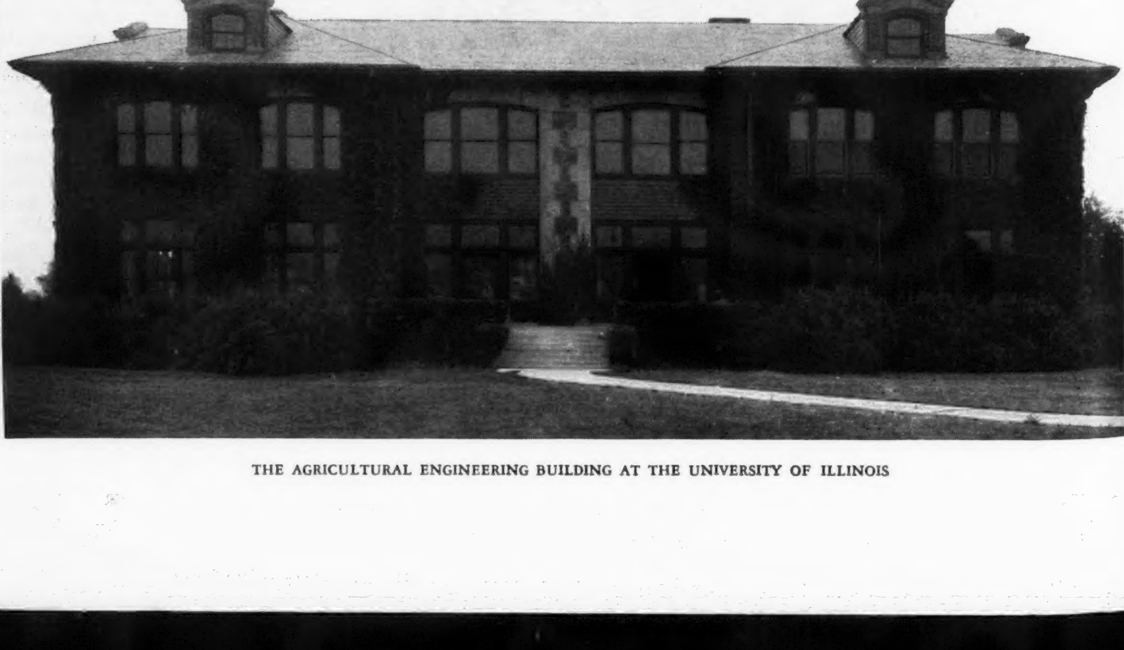
2 In Equation 19, the last term should be "*c*" rather than "*C*".

3 In the third line from the bottom of page 142, the term "*C*" should have no subscript.

4 The left-hand member of the first equation in the right-hand column on page 143 should be letter "*z*" rather than figure "2".

* * *

ATTENTION is called to a transposition of captions in the article, entitled "Pressures and Loads of Ear Corn in Cribs," appearing in the April 1934 AGRICULTURAL ENGINEERING. On page 125 the captions for Figs. 4 and 5 should have been reversed; that is, the larger cut in the left-hand column is Fig. 5, while the cut in the right-hand column is Fig. 4.



THE AGRICULTURAL ENGINEERING BUILDING AT THE UNIVERSITY OF ILLINOIS

Air Conditioning of Farm Buildings[1]

By Alfred J. Offner[2]

THIS PAPER describes the ventilating systems, with incidental air heating, as designed for a set of farm buildings recently erected and now in use. The buildings are located in Zone No. 2 as determined by and indicated on the standard map of climatic zones of the United States prepared by the U. S. Department of Agriculture. For this zone, the daily mean temperature at 8 a. m. for the months of January and February, is 17 deg (Fahrenheit), the monthly mean being 22 deg. The low outside temperature is taken as 0 deg. Based on stabling the cows at night, when the temperature drops below 50 deg, there are about 250 stabling days per year in this zone.

These buildings are of fireproof construction, with walls of stone. In addition to the buildings described, there are the usual silos, hay barn, and dairy buildings.

Design Data. The following table[3] is a summary of the data used in the design of the cow barn ventilating system, and is based on a unit of one cow, 3,000 Btu per hour heat available, 600 cu ft of barn air space, and 130 sq ft of building exposure:

	Temperature deg F			Per Cow Per Hour	
				Permissible heat losses per 1 deg F difference	
Zone	Daily Mean Jan. - Feb.	Barn	Ventilation cu ft	Per cu ft	Per sq ft of exposure
1	5	45	2600	0.043	0.197
2	17	50	3175	0.051	0.235
3	27	55	3550	0.066	0.305

For a cow barn temperature of 45 deg, Kelley[4] suggests 85 per cent relative humidity as a limit not to be exceeded. This figure was used in the design under consideration, although the barn temperatures were taken at 50 deg for the cows and 60 deg for the calves. For the horse stables, a temperature of 40 deg was assumed.

The Ventilating Systems. All the barns and stables, both for the cows and horses, have both air supply and air exhaust ventilating systems.

The air supply, which is unheated in every case, is taken into the building either through openings located on the outside face of the walls or through dormer windows located on the roofs of the buildings. The air is introduced into the barns and stables in every case near the top of the room, either through openings located on the face of the wall, or direct through the ceiling.

All air supply intakes are provided with louvres and screens, giving free entry for the air but preventing rain, birds, leaves, etc., entering the air supply systems. All air intakes further have the usual automatic back pressure dampers to prevent the reversing of the flow of air under adverse wind action. The air openings into the rooms can be close, opened, and controlled by hand.

The vitiated air is removed from the barns and stables through openings located on the face of the walls, both near the ceiling and near the floor.

Both exhaust openings are under manual control, so that either all the air can be taken out at the top of the room or all out at the bottom, or partly top and partly bottom. In the stall section of the horse stable, both openings have key-operated louvres, permitting air control, while in the box stalls the bottom openings have vertical iron bars in place of the register faces. In the cow barns, on account of their closeness to the cows and the possibility of contamination by the animals, the bottom openings are entirely open, having no grille or bars over them, and further are finished in hard cement to permit easy cleaning and washing out. The top openings have register faces. The air control in these cases is by means of a flap damper located in back of the top opening and operated from that point. Fig. 1 shows a typical section through an exhaust flue located in the cow barn, and indicates the method of control.

The air is removed from the barns by ducts and flues placed in the walls and attic spaces, and is discharged by means of fans to the outside through ventilators located on the roofs of the buildings. The exhaust fans are of the propeller type electrically driven by direct-connected electric motors, and generally are located under the ridges of the roofs. The exhaust fans have three speed controls, giving approximately 90, 75, and 60 per cent of synchronous speed. They can be controlled as to starting and stopping either manually or automatically.

In the attic spaces where hay is stored, vent openings are provided into the exhaust systems to remove air during warm weather when the hay is fresh, and also to prevent rotting of the hay should it become wet.

Air Heating. In order to prevent the cow barns from becoming too cold in severe weather, either in cases where the air cubage is in excess of that which can be kept at proper temperature by the available animal heat, or in cases where the barn is not fully stabled, means for artificially tempering the barn air has been provided.

The heating is provided for by the recirculation of the barn air through fin type unit heaters, warmed by low-pressure steam, the steam supply being either under hand or automatic control. The air is circulated by means of electrically driven fans of the propeller type. Fig. 2 shows a section of a typical unit heater, with air inlet and air outlet connections. Only one unit is provided for each of the barns.

No means of artificial heating has been provided for the horse stables.

Automatic Control. In the cow barns and in the horse stables the ventilation, and also the heating where provided, can be independently started and stopped by manual control, or both systems can be controlled automatically either together or separately.

In the horse stables, where only ventilation is provided, the automatic starting and stopping of the exhaust fans is actuated by thermostats located in the attic directly in the exhaust ducts from these rooms. Each fan unit has its independent control. These thermostats are set for the desired temperature to be maintained in the stable, the

[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers held at Harrisburg, Pennsylvania, January 1934.

[2]Consulting engineer.

[3]Cow Barn Ventilation, by Alfred J. Offner, (A.S.H. & V.E. Transactions, Vol. 39, 1933.)

[4]Technical Bulletin 187, U. S. Department of Agriculture (1930).

[5]Preventing Condensation on Interior Building Surfaces, by P. D. Close (A.S.H. & V.E. Transactions, Vol. 36, 1930).

fans operating when the temperature of the stable is at or higher than the desired temperature, but when the temperature drops lower the fans then stop, thereby conserving heat. The control panels, on which are located the control switches by which the fans can be started, stopped, or controlled automatically, are located on the stable walls, at heights for convenient operation.

The automatic control provided in the cow barns is somewhat different from that described for the horse stables, as in these buildings, in addition to the ventilation, the heating must also be controlled. Here the thermostats, instead of being placed in the ducts, as in the horse stables, are placed directly in the barns. Each barn has one control panel, on which is mounted, in addition to the control switches for the exhaust fans, also a switch for controlling the heating unit and two thermostats. One thermostat controls one-half the total number of fans ventilating the barn, the other thermostat controlling the remaining fans and also the unit heater. The thermostats are set at about a 5-deg temperature differential, the one controlling half of the fans and the unit heater being set at the desired barn temperature, namely 50 deg, the second being set at about 55 deg.

The automatic control will then be as follows: At temperatures of 55 deg and higher all exhaust fans will be running, heat being off, and the unit heater not operating. When the barn temperature starts to drop and reaches 55 deg, one-half the exhaust fans stop running, reducing the amount of cold air being pulled through the barn, and thereby starting to conserve heat. The heat would still be off. When the barn drops to the desired temperature of 50 deg the second set of exhaust fans stop and the heat goes on, there being a one to two-degree lag between the two operations. The heat stays on until the desired temperature is reached, and if the temperature keeps rising, the heat turns off and the control of fans operates in reverse to that just described. As in the horse stables, both the ventilation and heating can also be controlled manually.

The Cow Barn Building. The cow barn building, in addition to the usual feed and utility rooms, consists of three barns — the milking cow barn (wet stock), cow pen barn (dry stock), and the calf barn. The dairy building adjoins the cow barn, but there is no direct connection between the two buildings.

The Milking Cow Barn. The milking barn (wet stock) is a room 38 ft wide, 47 ft long, and 9 ft high (average), having a cubage of 16,074 cu ft. In addition to the milking parlor, there are stalls for eighteen cows. The barn air cubage to be maintained at proper temperature by the heat produced by one cow is 893 cu ft, which is greater than the 600 cu ft air cubage generally assumed. Based on a barn temperature of 50 deg and an outside temperature of 0 deg, the heat losses through the exposed parts of the room, such as windows, walls, and ceiling, figures as 51,400 Btu per hour. To maintain the desired thermal balance, it will then be necessary for each cow to produce 2,855 Btu per hour, which is less than the 3,000 Btu per hour available from one average cow. Even with the larger barn cubage per cow provided, it will be possible, due to the better type of building construction used, to keep the barn during the coldest weather at the desired temperature by means of the available animal heat, providing the barn is fully stabled. When the number of cows housed is less than the maximum, the heating system provided has to be used. Based on the actual barn air cubage, the heat loss per hour per cow for 1 deg difference figures as 0.063 Btu per cu ft and 0.203 Btu per sq ft of building exposure.

This barn has two exhaust fans, each capable of removing 800 cu ft of air per minute against the static pressure present, or for both fans a total of 96,000 cu ft per hour. Based on eighteen cows, this will provide for each cow 5,333 cu ft, or at 60 per cent of full speed, 3,200 cu ft per hour.

The Cow Pen Barn. The cow pen barn (dry stock) is 38 ft wide, 64 ft long, and 9 ft high, or a cubage of 21,888 cu ft. This barn has ten stalls and seven pens, space for a total of seventeen cows. The barn cubage per animal amounts to 1,287 cu ft. The heat losses from the structure for a 50-deg rise are 57,700 Btu per hour, or 3,394 Btu to be produced per cow. This barn will therefore probably require some artificial heating in very cold weather. The heat loss per hour per cow per 1 deg difference for this barn works out as 0.053 Btu per cu ft, and 0.179 Btu per sq ft of building exposure.

The Calf Barn. The calf barn is 24 ft wide, 26 ft long, and 8 ft high, a cubage of 4,992 cu ft. While there are only six pens in this barn, the number of calves that can be housed is of course considerably more than this number. The heat losses from this room are 26,000 Btu per hour, based on heating this barn to 60 deg. This heat produced by a calf varies with its age and weight. Based on the assumption

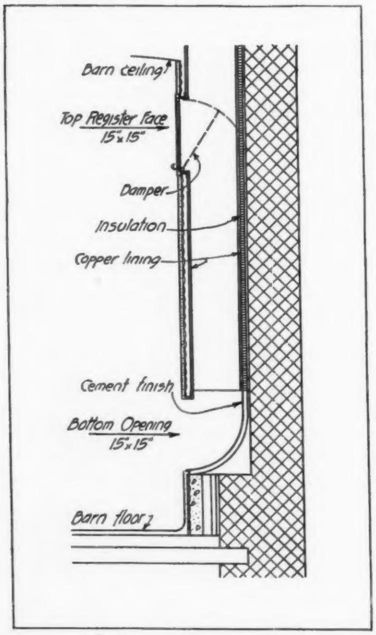


FIG. 1 SECTION THROUGH EXHAUST FLUE IN COW BARN

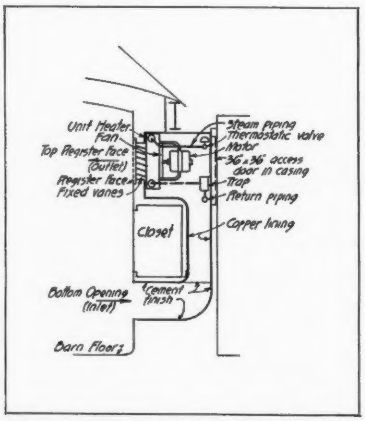


FIG. 2 TYPICAL DETAIL OF UNIT HEATERS IN COW BARNS

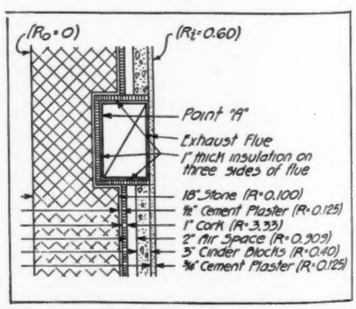


FIG. 3 WALL CONSTRUCTION, SHOWING EXHAUST FLUE

that three calves averaging six months in age produce heat equivalent to that given off by one cow (3,000 Btu) of average weight, one calf would produce about 1,000 Btu. To keep the barn at the desired temperature of 60 deg in extreme weather would then require twenty-six calves averaging six months in age. This barn will most likely require artificial heating in very cold weather.

The Horse Stable. The horse stable building has, in addition to the usual feed, harness, and utility rooms, two stables, one having stalls and the other box stalls. As already stated, no artificial heating is provided for this building.

The Stall Stable. The stall stable is approximately 23 ft wide by 82 ft long, and 10 ft high, with an actual cubage of 20,200 cu ft. There are seventeen stalls. The heat losses, based on 40 deg with an outside temperature of 0 deg, comes to 48,000 Btu per hour, requiring each horse to produce about 2,800 Btu per hour to maintain the thermal balance. A horse of 1000 lb weight gives off about 1800 Btu per hour, and one weighing 1500 lb, about 2500 Btu per hour.

This stable has three exhaust fans, each removing 800 cu ft of air per minute against the static pressure present, or for all fans a total of 144,000 cu ft per hour. Based on the total of seventeen horses stabled, this will provide per horse about 8,000 cu ft of air per hour at full speed of the fans, and 4,800 cu ft at 60 per cent of full speed.

Box Stall Stable. The box stall stable is 28 ft wide, 47 ft long, and 10 ft high, a cubage of 13,160 cu ft. There are six box stalls and four stalls. The heat losses here, for a 40 deg rise, are 38,400 Btu per hour. Based on a total of ten horses, each horse will have to produce about 3,840 Btu per hour to maintain the thermal balance.

There are two exhaust fans of capacity equal to that provided in the stall stable. This will provide per horse, at full speed, 9,600 cu ft per hour, or 5,760 cu ft at 60 per cent of full speed.

Condensation. Due to the high relative humidities and low air temperatures encountered in farm buildings, special consideration must be given to the prevention of condensation forming on exposed walls, ceilings, etc. Damp and dripping walls and ceilings not only cause deterioration of the building structure and contents, but also affects the health and efficiency of the animals housed therein.

Condensation on a surface is caused by the contact of warm humid air with surfaces that are below the corresponding dew point temperature. Condensation can therefore be eliminated either by reducing the humidity so that the dew point will be below the temperature of the surface with which the air comes in contact, by increasing the surface temperature to above the dew point, or by adding heat resistance to the construction.

The total amount of moisture or absolute humidity in farm buildings depends on the kind, number, and size of animals housed, on the humidity of the incoming air, and on the amount of ventilation provided. As a basis for calculating the structural resistance to condensation in the farm building under discussion, a relative humidity of 85 per cent was assumed, with a barn temperature of 50 deg dry-bulb temperature and an outside temperature of 0 deg.

In order to determine the total resistance, *R*, which the various exposed structural parts of the building, such as walls, ceilings, etc., must have to maintain the interior surface at a temperature higher than the dew point temperature corresponding to 85 per cent relative humidity, the following formulas were used:

$$R = \frac{R_s\ (t_i - t_o)}{t_i - t_s}$$

in which R is the total resistance, R_s (= 0.6) the interior surface resistance, T_i is the inside air temperature, T_o the outside temperature, and T_s the temperature of the interior surface.

For all surfaces exposed to the outside air the total resistance to prevent condensation would then be

$$R = \frac{0.6 \times 50}{50 - 45.7} = 7.00$$

The wall construction as indicated in Fig. 3, using the resistances as given in the A.S.H. & V.E. Guide for 1932, the year the work was under design, the total resistance of the walls is as follows:

18-in stone	18 x 0.10	=	1.800
½-in cement plaster	0.5 x 0.125	=	0.063
1-in cork	1 x 3.33	=	3.330
Air space		=	0.909
3-in cinder blocks	3 x 0.40	=	1.200
¾-in cement plaster	0.75 x 0.125	=	0.094
	Total resistance (*R*)	=	7.396

As the actual total resistance of the wall construction (7.4) is slightly greater than the calculated resistance (7.0), this indicates that no condensation will form on the room side of the walls under the assumed conditions.

In connection with the vertical exhaust flues concealed in the outside walls, and also illustrated by Fig. 3, it is of interest to note that the total resistance up to the wall of the flue adjacent to the outside wall ("A") figures 4.90, which is less than the required resistance of 7.00. At outside temperatures below 15 deg, condensation should form on the inside of these flues, trickling on to the floor through the bottom openings.

For the ceiling construction, with an unheated attic space above assumed at a temperature of 30 deg, the total resistance to prevent condensation figures as 4.0. The ceiling over the cow barn consists of plaster backed with insulation, the resistance of which figures as 4.2. There should therefore be no condensation forming on those surfaces.

Life of Temporary Dams

CHECK dams made from brush will last from two and a half to three years, say U.S.D.A. engineers. This is time enough for vegetation to grow on the silt accumulated in the gullies and to prevent erosion of the soil.

Pole dams, which are more efficient in catching silt than brush dams, decay fairly rapidly but will last about a year longer than brush dams. After standing up for three years or more, pole dams will sometimes give way during a series of heavy rains.

Time seems to solidify rock dam construction by adding a heavy blanket of silt and grass and similar debris. Rock dams last longer than any other type of temporary check dam.

Woven wire dams are efficient and economical for depths of fill not exceeding three feet. They will last about three years, and, in that time, will catch a substantial quantity of silt, leaves and branches.

A Combined Feed Grinding and Mixing Unit[1]

By Hobart Beresford[2] and F. W. Atkinson[3]

GRINDING and mixing homegrown grain on the farm is recognized as a part of an economical feeding program. The time required and the regularity of these tasks justifies consideration of methods of minimizing the labor necessary. That the need for feed mixing equipment has been recognized is evidenced by the various types of machinery on the market for this purpose. Due to the original cost and difficulty in adapting the machines to individual requirements, the practice of hand, or scoop, mixing still remains a burden to the average dairyman. Besides the labor involved, hand mixing is a disagreeable task because of the dust, particularly if done in a small room. By using electric motor power, feed grinding may be handled as part of the regular chores, thereby saving time during the middle of the day.

A combination feed grinding and mixing unit was specially designed for and built in the University of Idaho dairy barn[4]. It has been in use about a year and a half and with some minor changes has proven quite satisfactory.

The utilization of the hammer-type feed mill for elevating, grinding, or mixing feed is based on the use of a blower elevator for transferring the whole grain, ground grain, or feed mixtures from one bin to another. Mixing feed by alternate piling and discharging from one bin to another permits the maximum utilization of the feed grinding equipment. In adapting the unit to individual farms, changes will be required to meet the limitations and needs of each dairyman.

The feed grinder used is a swinging hammer-type mill known to the trade as "Whip-it No. 1," manufactured by the Rowell Brothers Company, Waukesha, Wisconsin. The grinder is equipped with a blower elevator for elevating feed after it has passed through the grinder. To the frame of the original was bolted an auxiliary hopper containing an agitator similar to the one in the grinding hopper. By means of this extra hopper, called the elevating hopper, it is possible to elevate grain or mixed feed without passing it through the grinder. The location of the elevating hopper and valve made it necessary to replace the original round suction pipe with a suction pipe of a greater arc and a rectangular cross section. When the unit is used for elevating only, the suction pipe which carries the ground grain to the blower elevator is replaced by a flared inlet which tends to increase the velocity of the air forced into the blower.

Originally the round 4-in blower pipe extending upward from the blower fan was connected with the dust collector upstairs by a short radius, round-section elbow. This short elbow tended to clog and was replaced by a 30-in radius, rectangular-section "gooseneck," which proved satisfactory and materially increased the elevating capacity of the unit.

[1]Published with the approval of the Director of the Idaho Agricultural Experiment Station as Research Paper No. 119. Released for first publication in AGRICULTURAL ENGINEERING.

[2]Head, department of agricultural engineering, Idaho Agricultural Experiment Station. Mem. A.S.A.E.

[3]Head, department of dairy husbandry, Idaho Agricultural Experiment Station.

[4]Developed as a cooperative project in the Departments of Agricultural Engineering and Dairy Husbandry, Idaho Agricultural Experiment Station, and the Idaho Committee on the Relation of Electricity to Agriculture.

Power is supplied by a 220-v, three-phase, 7½-hp Century portable electric motor. A 3-hp motor would have furnished sufficient power and would have been cheaper in the cost of both installation and operation, but the portable 7½-hp motor was selected because it was needed for other purposes. The feed grinder is operated at 3200 to 3300 rpm (revolutions per minute); the 6-in pulley of the grinder is connected with an 11-in pulley on the motor by a four-strand, 21/32-in Texrope V-belt. This transmission unit has a 10-hp capacity and operates on a center-to-center distance of 24½ in, thus requiring a minimum amount of floor space for the motor and mill.

All bins are rat-proofed by means of a ¼-in mesh hardware cloth nailed between double lining. On the second floor two sack dumps are provided for the southeast and southwest bins. The arrangement permits separate filling and discharging. This prevents the ground grain mixture from channeling, which occurs when one bin is filled and discharged as a single operation.

The dust collector is mounted above the partition intersection of the four bins, making a total lift of 23 ft. The two-way valves on the dust collector delivery spouts may be operated from the grinding room on the first floor by a simple control system of pulleys, sash cords, and weights, making possible the discharge from the dust collector into any one of the four bins.

The tray connecting the bin discharge spout with the grinding hopper is fitted with a series of magnets. Nails, screws, pieces of bailing wire, and other ferrous materials are removed from the grain before it passes into the grinder. The annual loss of valuable dairy animals due to foreign bodies is enormous and to appreciate the necessity for the magnets one only needs to observe the material collected on them.

Grinding and mixing are carried on separately in order to keep the power demand at a minimum and to avoid the necessity of regrinding such feeds as bran, linseed oil meal, etc. The procedure for grinding 400 lb of oats and barley (equal parts by weight) and for mixing a 970-lb batch of feed is illustrated in the accompanying drawing. The oats

TABLE I. FEED GRINDING AND ELEVATING DATA

Kind of grain, or mixture	Screen perforation size, in	Moisture content, per cent	Fineness modulus	Rate of grinding lb per hr	Kwh per ton
Barley	⅜	11.3	3.69	696	9.00
Corn	⅜	15.4	2.50	706	10.00
Oats	⅜	13.0	3.52	750	7.00
Wheat	⅜	12.6	2.94	1,090	11.00
Oats and barley	⅜			857	10.48
Oats and barley	¼		3.83	800	11.00

FEED MIXING DATA

Rate of elevating feed mixture	3,000 lb per hour
Energy consumption for elevating	1.5 kwh per ton
Bin mixing of feeds	1,000 lb per hour
Energy consumption for mixing	4.5 kwh per ton

BRIEF SPECIFICATIONS FOR GRINDING EQUIPMENT

Manufacturer: I. B. Rowell Co., Waukesha, Wis.
Type: Swinging hammer
Name: "Whip-it No. 1"
Screen: ¼-in perforation
Screen: ⅜-in perforation
Motor: 7½-hp, 3-phase, 220 v
Size of hammer: 13¾-in diameter; 6-in length
Elevator: Blower
Speed: 3200-3300 rpm
Drive: V-Belt 21/32, 51-in, four-strand Texrope
Pulley size: Motor, 11-in; mill, 6-in

and barley to be ground are dumped into the southeast bin through the sack dump (One-A). The other feeds, bran, linseed oil meal, cotton seed meal, and salt, are dumped into the southwest bin (One-B). The oats and barley in the southeast bin (One-A) are then ground and elevated into the southwest bin (One-B). This places the entire batch of feed in the southwest bin (One-B), the ground oats and barley being on top. In the first step of the mixing process the feed is gradually drawn off into the elevating hopper from which it passes through the blower elevator into the southeast bin (Two-A). In the second mixing operation the feed is again drawn into the elevator hopper and blown into the southwest bin (Three-B). In the third bin transfer the feed is blown from the southwest bin (Three-B) into one of the north bins (Four-C) where it is stored ready to be drawn off by gravity flow through the feed chutes into the feed trucks as needed. In the bin method of feed mixing three transfers have been found sufficient for thorough mixing. Better mixing results when the lighter feeds not to be ground, such as bran, are dumped into the bin first and the other feeds dumped in the order of their weight per unit of volume.

The bins used for the grinding and mixing operations are the southwest and southeast bins which have a respective capacity of approximately 8000 and 5000 lb of grain or feed mixture. The amount of feed that can be mixed at one time is limited by the capacity of the southeast bin. It would be desirable to have these two bins the same size.

A study was made of the capacity and energy consumption of the grinder. Barley, oats, and corn were ground separately, using a 3/8-in screen. The rate of grinding was approximately the same (700 lb) per hour for these grains, but about a third more wheat was ground under the same conditions. When barley and oats were ground together in equal parts by weight, the rate of grinding was about 20 per cent faster than when either of these grains was ground separately. This was apparently due to a more uniform rate of flow into the grinder. After passing through the 3/8-in screen the grains were about the proper degree of fineness for dairy cattle. When a 1/4-in screen was used in grinding barley and oats together, the rate of grinding and the power consumption were very similar to the results obtained with a 3/8-in screen.

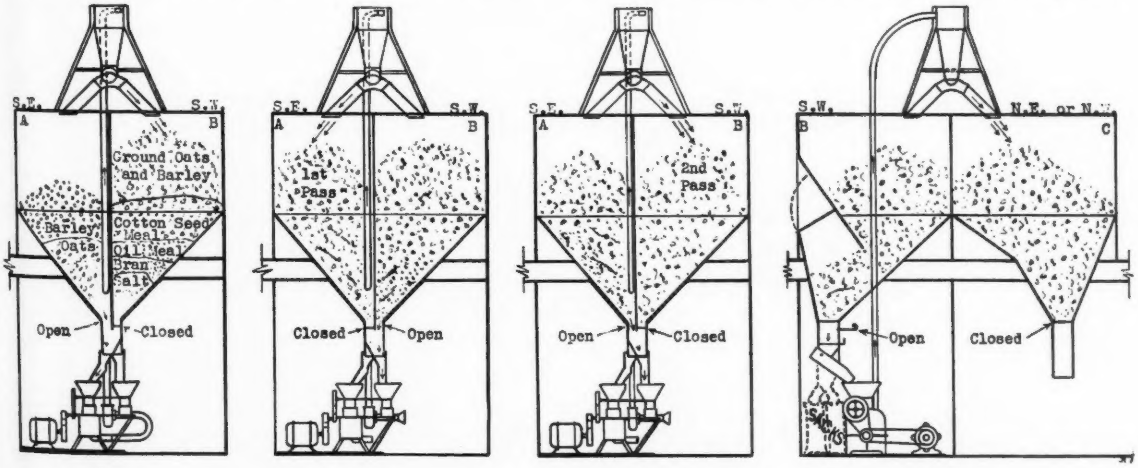
Electric energy used per ton in grinding and elevating was 11 kwh (kilowatt-hours) for wheat, 10 kwh for corn, 9 kwh for barley, 7 kwh for oats, and 10.48 kwh for barley and oats mixed. Under average conditions about 800 lb of grain can be ground and elevated per hour with an average energy consumption of 10 kwh per ton.

Study of the bin method of feed mixing, or, in other words, elevation without grinding, showed that the ration used was elevated at the rate of 3000 lb per hour with an energy consumption of 1½ kwh per ton. The increased rate of elevating feed during the mixing process compared with the grinding process was due to the presence of light feeds, such as bran, in the mixture and to the increased air velocity in the blower because of the greater arc on the suction pipe. Since three transfers of feed were required, the mixing may be completed at the rate of 1000 lb per hour. In other words, 4.5 kwh of electric energy and two hours time were required to mix a ton of feed.

Since the grinding and mixing processes are completed as separate operations for the most efficient use of the unit, the time required for the combined grinding and mixing of a ton of the ration used in this study was 3 hr, 1 hr for grinding 800 lb of barley and oats, and 2 hr for mixing the barley and oats with 1200 lb of other feeds. The total power requirement for the grinding and mixing of a ton of the rations used was 8.5 kwh, 4 kwh for grinding the 800 lb of barley and oats and 4.5 kwh for mixing the entire ton.

In this installation the grinding process requires very little attention and the labor of mixing feed is reduced to a minimum. The fact that grinding and mixing feed may be done at chore time, thereby saving time during the middle of the day, is an important feature in the organization of labor on most dairy farms. The grain to be ground and the other feeds to be mixed to make up a 1000-lb supply are dumped into two bins in about ten minutes just previous to starting the other evening chores. The grinder is started and no more time is required except for the pulling of controls in making bin transfers. Anyone working in the barn can tell by the sound of the grinder when a bin is completely discharged and the grinder is running empty.

About one hour is required to dump and mix 1000 lb of feed by hand scooping, while not to exceed 15 min is required by the bin mixing method. At 30 cents per hour the saving in time, in mixing alone, would more than pay interest on the investment in the entire unit, if feed is mixed every second day. In considering the cost of the unit, attention is called to the fact that *(Continued on page 166)*



One Two Three Four

THESE DRAWINGS SHOW THE PROCEDURE IN THE FEED GRINDING AND MIXING OPERATIONS IN THE IDAHO STUDY

Control of Soil Erosion by Terracing[1]

By C. E. Ramser[2]

THE TERRACING experiments on the various federal soil erosion experimental farms are planned so as to answer important questionable matters relating to the best terrace design and practices. For instance, in the graded terrace experiments where the terraces are given fall to dispose of the water at the ends of the terrace, the principal information being collected consists of the proper size of the terrace channel, the proper distance between the terraces, the required fall of the terrace channel, and the limiting length of a terrace for any particular soil, land slope, or vegetative cover. These factors are dependent upon one another so that a change in one affects all the others. It is the problem of the engineer to adjust the relation of these factors in such a manner as to prevent any appreciable erosion on the land slope between the terraces and in the terrace channels and also to provide sufficient capacity in the terrace channel to prevent the runoff water from overtopping the terrace.

Terraces Conserve Soil. The effectiveness and value of terraces in reducing soil losses has been conclusively demonstrated by several of the soil erosion control stations. On the Red Plains Stations near Guthrie, Oklahoma, the soil losses from an unterraced area during a two-year period averaged 66 tons of soil per acre per year as compared with an average of 2.65 tons of soil per acre from a terraced area, both areas being cropped quite similarly and the average rainfall being about normal for the two-year period. That terraces are effective in controlling erosion on the experimental farm at La Crosse, Wisconsin, is evidenced by the fact that while terraced land planted to barley lost less than 150 lb per acre during two rains totalling about 3½ in, the loss from unterraced land similarly cropped was 3.56 tons per acre, or over forty times as great. The value of terraces in reducing erosion losses on land planted to wheat at Bethany, Missouri, is apparent from the record of soil losses during one rain of 1.17 in. During this rain only 60 lb of soil per acre were lost from a terraced area as compared with 2,100 lb per acre from an unterraced area, thirty-five times as much soil being lost from the unterraced as from the terraced area.

Economy to Terrace Land. The rapid depletion of the fertility of the soil on the Guthrie farm due to soil erosion was manifested by a comparison of crop yields obtained on virgin land first broken when the station was established and badly eroded land that had been in cultivation for over thirty years. Over forty bushels of oats per acre were produced on the virgin land as compared with about fifteen bushels per acre on the badly eroded land. It was found by actual measurements of the soil losses on terraced areas that erosion proceeds nearly twice as fast on badly eroded as on virgin land, and by actual cost records that the cost of terracing badly gullied land was over six times as much as the cost of terracing virgin land before any gullies had developed. The foregoing results demonstrate conclusively the advisability of starting the control of erosion on land when it is first broken, rather than waiting until erosion has begun its destructive work. To repeat, early terracing insures first the maintenance of crop yields; second, cheaper terraces per acre of land terraced resulting from a possible wider spacing of terraces; and, third, the cheaper construction of terraces on virgin than on gullied areas.

Soil Loss Tremendous on Slopes. The opinion quite generally prevails that soil erosion is confined largely to the steeper land slopes, and as a result not much attention is given to preventive measures on moderately sloping land. In order to collect reliable data on this subject, an experiment was included in the cooperative erosion program on the state experiment station near Ardmore, Oklahoma, which consisted of measuring the run-off and soil losses from an unterraced land slope of 1.9 per cent. Shortly after the installation of the measuring equipment a rain of 6.1 in occurred causing a soil loss of approximately 11.1 tons of soil per acre. After comparing this loss with a loss of 14.5 tons of soil per acre on a 5.1 per cent slope at the Guthrie farm for a 3-in rain, it is apparent that soil erosion is indeed a serious problem even on land slopes as small as 2 per cent.

Soil Losses Increase with Grade. The effect of fall or grade of terrace upon soil losses was plainly demonstrated in experiments at the Guthrie and Bethany farms. An experiment on the Guthrie farm where the grades of the terraces were level, 2, 4, and 6 in per 100 ft gave soil losses of 2.65, 4.63, 5.29, and 10.26 tons per acre, respectively. The terrace with the 6-in grade lost about four times as much soil as the level terrace and about twice as much as the terraces with the 2 and 4-in grade. The results at Guthrie were corroborated by experiments at Bethany where the soil losses increased from 0.63 tons to 7.27 tons per acre for terraces with grades as follows: level, 2 in, 4 in, 6 in, and 8 in per 100 ft. Appreciable scouring in the channels with 6 and 8 in fall per 100 ft was plainly visible at both Guthrie and Bethany. At Guthrie both years the yields of cotton and corn were less for the level terrace and for the terrace with a 6-in grade, and it appears that the smaller yield in the level terrace channel was due to partial drowning of the crop, and in the 6-in graded terrace channel to the washing out of some of the small plants due to the high velocity of the water. From these results it appears that sufficient grade should be given a terrace to provide satisfactory drainage of the terrace channel and yet not so large as to cause appreciable erosion.

Superiority of Variable Graded Terrace. The relative merits of a variable and uniform graded terrace has been a much discussed subject. Experiments designed to collect data for the purpose of comparing these two types of terraces are being conducted on several of the soil erosion farms. A variable graded terrace has a grade which increases from the upper to the outlet end of the terrace. The principle of the variable graded terrace is that the upper end of the terrace with a small grade tends to store or hold back the run-off water until the water below where the grade is greater has a chance to flow off thus preventing the piling up or concentration of the water near the outlet end of the terrace which often results in a terrace break.

Two terraces on the Tyler farm, one with a uniform grade of 6 in per 100 ft and the other with a variable grade of 0 to 6 in per 100 ft lost an average of 7.95 and 6.8 tons of soil per acre, respectively, annually for a two-year period, the uniform graded terrace losing 17 per cent more soil

[1]Paper presented at fourth Southwest Soil and Moisture Conservation Conference, Texarkana, Texas, July 1933. Abridged.

[2]Senior drainage engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

than the terrace with the variable grade. Two other terraces 1,700 ft long, one with a uniform grade of 3 in per 100 ft and the other with a variable grade of 0 to 3 in per 100 ft, lost an average of 5.15 tons and 4.15 tons of soil per acre, respectively, the uniform graded terrace losing 19 per cent more soil than the variable graded. A terrace on the Bethany farm with a uniform grade of 4 in per 100 ft lost 31 per cent more soil than a terrace with variable grade of 1 to 4 in per 100 ft. These results show a consistent tendency to smaller soil losses from the variable than from the uniform graded terraces, which justifies giving preference to the use of the variable graded terrace.

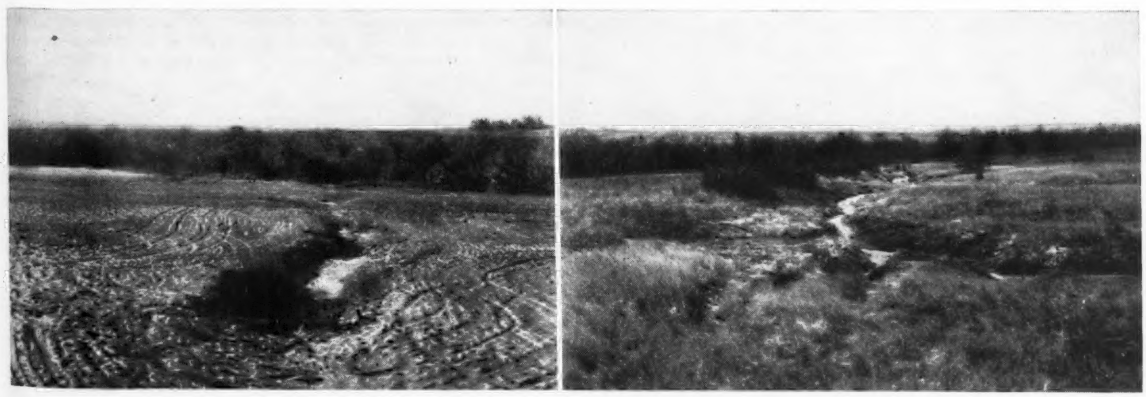
Short Terraces Preferable. Long terraces showed a greater soil loss than short terraces on the Tyler farm. A terrace 700 ft long with a vertical spacing of 4 ft and a uniform grade of 3 in per 100 ft showed average annual soil loss for a two-year period of 3.55 tons per acre as compared with 4.85 tons per acre for a terrace 1,700 ft long with the same spacing and grade. It is believed that the greater volume of water in the terrace channels of the longer terraces causes more erosion and carries away more soil than has moved down the slope into the terrace channel. From these results it appears that short terraces are to be preferred to long terraces and should be used wherever the controlling conditions permit.

How Spacing Affects Losses. Variations in the results of the terrace spacing experiments on the different farms made it rather difficult to arrive at any definite conclusions with regard to spacing terraces. An experiment at Tyler, Texas, consisting of three terraces 1,700 ft long and with vertical spacings of 3, 4, and 5 ft gave soil losses increasing with the spacing of the terraces during two successive years when the terraces were planted to cotton and corn. The average annual soil losses in tons per acre were 3.17, 4.83, and 5.16 tons, respectively. Similar results were obtained on the Guthrie project for terraces 700 ft long and with spacings of 2, 3½, and 5 ft when soil losses of 2.74, 3.96, and 4.98 tons per acre, respectively, were obtained when the terraces were planted to corn in 1931. The next year when these same terraces were planted to oats, the soil losses were about the same regardless of spacing. It appears that this difference in the results was due to the development of small gullies on the wider spacings when in corn and the absence of such gullies when in oats. The results at Guthrie seem to indicate that soil losses increase with the spacing of the terraces when the ground is bare, fallow, or cropped to clean cultivated row crops and are not much affected by the spacing when the land is cropped to close-growing grain crops. Results at Tyler and Bethany for short terraces planted to cultivated crops do not verify the above conclusions since there were no large differences in the soil losses at Tyler for terraces 700 ft long with different spacings and for two sets of terraces 700 and 1,040 ft long with different spacings at Bethany. Conditions on the various terraces in the Guthrie experiment are quite uniform and the experiment is duplicated, so more weight is given to the results of the Guthrie experiment. Uniformity in condition of terraces in an experiment improve with age, and it is felt that additional data will be required at both Tyler and Bethany for short terraces before definite conclusions with regard to spacing can be formulated.

Observations indicate that gullying between terraces is much worse for the wider spacings and as a result the accumulation of soil is greater in the terrace channel. This greater deposit of soil in the channel of the terrace with wider spacing would tend to result in greater soil losses for wider spacing, especially for long terraces, since the volume of water removed by long terraces particularly near the outlet end is much greater than for short terraces, and also the water moves off at a greater velocity which is sufficient to carry away a large amount of soil deposited in the terrace channel. Since the velocity of the water also increases with the grade of the terrace, no doubt the greater the grade of th terrace the more pronounced will be the increase of soil losses with increase in terrace spacing particularly for long terraces.

Level Terraces Not Generally Satisfactory. Experiments with level terraces at Tyler, Temple, Guthrie, and Bethany where all of the rain is retained above the terraces to increase moisture supply for crops indicate that this practice is not advisable in regions of high annual rainfall and tight soils. While this practice has resulted in increased crop yields of from 25 to 40 per cent in the western part of Texas and Oklahoma where the annual rainfall is light and the soil is comparatively open, it was found on the Guthrie farm that damage done to an oats crop by water standing above the terraces resulted in a decreased yield of 60 per cent and somewhat similar results were obtained at the Tyler, Temple, and Bethany stations. Similar level terrace experiments are included in the program of all of the experimental farms, the results of which will afford an index for comparing the rate of percolation of water into the different soils in addition to data on the beneficial or deleterious effect of conserving all of the moisture for crop production. Accurate information on this subject is desired in order that definite recommendations with regard to this practice in different sections of the country can be made.

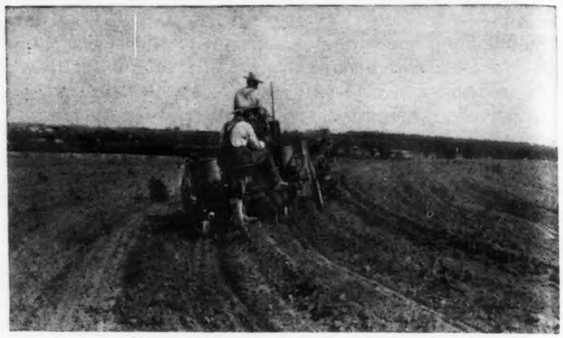
Terracing Steep Slopes. It has generally been con-



THESE PICTURES SHOW TWO GULLIES ON THE GUTHRIE (OKLAHOMA) FEDERAL SOIL EROSION EXPERIMENTAL FARM IN THE EARLY STAGES OF THE APPLICATION OF CONTROL MEASURES USED TO CHECK FURTHER EROSION

sidered inadvisable to attempt to terrace slopes for cultivable purposes greater than 12 to 15 per cent. However, it is desired to obtain definite information with regard to this matter so that much steeper land has been terraced on several of the federal farms. On the farm at La Crosse, Wisconsin, cultivated slopes of 25 per cent and pasture slopes of 30 per cent have been terraced and so far the results of this terracing work have been quite satisfactory. At the Pullman farm in the Palouse region of Washington cultivated slopes as high as 40 per cent have been terraced. However, erosion in that region is caused by light rains and rapidly melting snows and results obtained in that country on steep slopes would not apply to similar slopes in the Middle West.

It is difficult to make accurate comparisons of the damage done by soil erosion on the various soil erosion control farms owing to the differences in the fertility and depth of surface soil, annual rainfall, intensities of rain, season of heaviest rainfall, topography, crops, and farming practices. Satisfactory comparisons could only be made after experimental results have been obtained on all of the farms for a period of years. The prevailing general opinion has been that soil erosion is much more destructive and injurious to agricultural lands in the South than in the North. Results so far obtained at Bethany seem to challenge the validity of this opinion, since the record of soil losses on corn land for the year 1931 at Bethany with cotton land at Guthrie indicate larger soil losses at Bethany than at Guthrie for the year 1931 and about the same for the year 1932. The



A TRACTOR PLANTER BEING OPERATED ON THE LOWER SIDE OF A TERRACE RIDGE

rainfall at Bethany for the year 1931 was above normal and at Guthrie it was below normal for the year 1931 and above normal for the year 1932, which as stated above makes it rather difficult to arrive at an accurate comparison. However, the financial value of the losses from soil erosion are no doubt larger at Bethany than at Guthrie, particularly when the far greater fertility value of the Bethany soil is considered. Hence, the landowner in that region should be even more concerned than the Southern farmer about his enormous annual soil losses that will in a comparatively short time result in the removal of practically all the fertile top soil.

A Combined Feed Grinding and Mixing Unit

(Continued from page 163)

the labor-saving, feed-mixing system herein described costs very little in itself as the grinder, motor, and storage bins are investments common to all farms where it is the policy to grind home-grown grains on the farm.

SUMMARY

Grinding and mixing of homegrown grain on the farm is recognized as a part of an economical feeding program. A combination of feed grinding and mixing unit was installed in the University of Idaho dairy barn as a labor-saving device. A hammer type mill, driven by an electric motor, was used for grinding, elevating, and mixing feed. By adding an auxiliary hopper with agitator to the grinder, and making some other adjustments, grain or feed was elevated 23 ft through the blower pipe to overhead bins without passing it through the grinder. By alternately filling and discharging the bins the feed was thoroughly mixed after three transfers. Descriptive diagrams are presented and the method of operation is discussed.

The grinding and mixing processes were completed as separate operations for the most efficient use of the unit. Barley and oats were ground together at the rate of 800 lb per hour with an energy consumption of about 10 kwh per ton. With the ration used, 1000 lb of feed were mixed per hour by the bin method with an energy consumption of 4.5 kwh per ton.

The bin method of feed mixing minimizes labor, requires very little attention, and can be done at chore time, thereby saving time during the middle of the day. The extra cost for providing the feed mixing unit is very small, provided adaptable grinding and storage equipment is available.

It is also suggested that the belt and bucket type of elevator can be adapted to the bin method of feed mixing.

AUTHOR'S NOTE: The authors wish to acknowledge the assistance and cooperation of Charles E. Gabby, herdsman in the department of Dairy Husbandry, and T. Horning, graduate student in the Department of Agricultural Engineering of the Idaho Agricultural Experiment Station.

Objectives in Agricultural Engineering Education

WHAT is the final justification or objective of agricultural engineering? Is it not, as in other branches of engineering, helping people achieve more fully, with less waste of time and effort, the things for which they live and work? Is it not, in other words, the conservation of human values?

And does it not impose upon its teachers a need of unusual pedagogic foresight and efficiency? Foresight as to the probable future opportunities for the requirements of agricultural engineers? Foresight as to the possibilities and probable capacities of their students? Efficiency in the utilization of the student's time and energy in uncovering and developing their latent capacities? Should they not, as teachers of efficiency, be leaders in efficient teaching?

Should not agricultural engineering education be guided with broad vision by all that is best in related engineering and agricultural sciences, and in educational methods?

Should agricultural engineering teachers not feel a responsibility—to the individuals taught, to the public, to the agricultural engineering profession—for conservation of human values in their process of education as well as in the processes of agriculture?

SOIL CRUSTS[1]

Methods of Study, Their Strength, and a Method of Overcoming Their Injury to Cotton Stand

By A. Carnes[2]

ONE OF THE GREATEST problems in cotton production is to obtain a regular stand. The crust that is formed after rains, on some soils, frequently results in a poor stand. It is the purpose of this paper to present the methods used in studying soil crust in this investigation and the preliminary results obtained.

Mechanical analyses show that surface soils generally contain a sufficient quantity of soil colloids to produce a crumb structure under proper tillage. Rain water breaks down the binding power of the moisture films in the surface layer and tends to destroy the crumb structure of the soil. The force of the falling rain agitates the surface of the soil bringing the colloidal clay particles into suspension. They are then filtered out near the surface as the water percolates through the soil, thus producing a condition which, on drying of the surfaces, results in the formation of crust. The strength of the crust frequently is sufficient to prevent the young plants from reaching the surface when germinating in a loose deep seed bed.

Russell[3] observed that soils containing 40 per cent or more of fine sand tend to favor, after rain, a hard surface crust through which young plants make their way with difficulty.

The tendency of crusts to form on soils is increased by deflocculating agents. It is a generally expressed idea by farmers that heavy applications of sodium nitrate from year to year on heavy clay soils, without the addition of vegetable matter, produce the condition that they call "crusting" or "baking." This is probably due, in part at least, to a dispersed condition brought about by the action of the sodium.

Methods of Studying Crusts

Materials Used. A group of soils varying in clay and sand content was selected for this study. These soils were air dried, ground, and put through a 20-mesh sieve before being used. The physical compositions of these soils are shown in Table I.

TABLE I. Soils Used in the Crust Formation Studies and Their Physical Compositions

Soil	Clay, per cent	Silt, per cent	Sand, per cent	Fine gravel, per cent
Cecil clay B	54.56	25.90	18.58	0.96
Cecil clay B ⅔, sand ⅓	36.08	15.70	47.94	0.28
Cecil clay B ⅓, sand ⅔	20.56	4.30	74.80	0.34
Susquehanna clay	51.44	15.74	32.78	0.04
Sumpter clay	64.56	30.66	4.62	0.16
Houston clay	48.04	45.90	5.88	0.18
Lufkin clay	82.72	14.06	3.14	0.08

Production of Artificial Crust in the Laboratory. The crust-forming action of water on natural soils was studied in the laboratory by applying water in a manner similar to natural rainfall.

Unglazed clay flower pots, 6 in in diameter and 6 in high, which had been treated to prevent absorption of water, were used as soil containers. The soil was placed in the pots without packing, and varying amounts of "artificial rain" were applied. The amounts applied were equivalent to 1/4, 1/2, 3/4, and 1-in rains. The apparatus for applying this water was made by punching very small holes, 1/4-in apart, in the bottom of a cylinder 6 in in diameter and 12 in high. The correct amount of water was poured into this cylinder when it was held 15 in above the soil container. This method of application of water was similar to natural rain. After the water was applied the soil was allowed to dry in the laboratory under controlled or measured conditions.

Method of Measuring the Breaking Strength of Crusts. An apparatus (Fig. 1) was devised to measure the breaking strength of the crusts that were produced. A section of crust was carefully cut out with a spatula, removed, measured, and supported on two knife edges a known distance (L) apart. A weight was then let down gradually on the section of crust half way between the supports. The weight was suspended by the spring of a Jolly balance. When the section of crust broke, the amount of the take-up in the spring indicated the weight (P) required to break the crust. From this the number of grams per square centimeter of cross section required to break the crust was determined. From these measurements and determinations the modulus of rupture was calculated. The standard modulus used is the value of R in the formula

$$R = \frac{3PL}{2bd^2}$$

when P is the weight required to break the crust section, L is the length of the crust section between end supports, b is the width of the crust section, and d is the thickness of the crust section. The data in Table II illustrates the the accuracy of this apparatus in measuring the

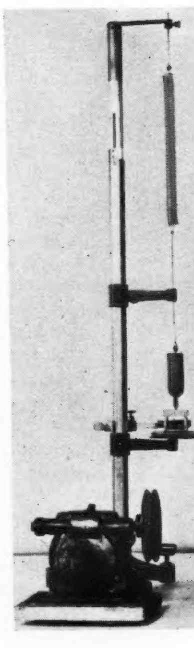


FIG. 1 APPARATUS TO MEASURE BREAKING STRENGTH OF CRUSTS

[1]Paper presented at a meeting of the Southern Section of the American Society of Agricultural of Agricultural Engineers, at Memphis, Tenn., February 1934.

[2]Assistant professor of agricultural engineering, Alabama Polytechnic Institute. Mem. A.S.A.E.

[3]Russell, Edward J. "Soil Conditions and Plant Growth."

[4]Baver, L. D. "Relation of the Amount and Nature of Exchangeable Cations to the Structure of a Colloidal Clay." Soil Science, vol. 29, no. 4, April 1930.

[5]Diseker, E. G., assistant agricultural engineer, Alabama Polytechnic Institute. Mem. A.S.A.E.

[6]Anderson, M. S., and Mattson, S. "Properties of the Colloid Soil Material," U.S.D.A. Bul. 1452 (1926).

[7]Bradfield, R. "Factors Affecting the Coagulation of Colloidal Clays," Journal Physical Chemistry, vol 32 (1928), pp. 202-208.

breaking strength of a crust produced with 1/4-in rain on a Cecil clay soil.

TABLE II. Modulus of Rupture of Crust Produced with 1/4-Inch Rain or Cecil Clay

Rain, in	Width of crust section used, cm	Thickness of crust cm	Weight to break crust, gm	Modulus of rupture R
1/4	1.7	0.9	150	164
1/4	1.8	0.9	147	152
1/4	1.8	0.9	142	148
1/4	1.6	0.9	139	158

From the data in Table II it is noted that the values of the modulus of rupture vary slightly in a crust produced with a given rainfall. It was noted that where small depressions formed in the soil during the wetting process, a greater force was required to break the crust. This was probably due to a greater concentration of colloid and other fine soil particles in the depressions which, as the surface dried, caused a greater cementation. In removing the crust sections it is possible that slight strains were produced, which could not be seen with the naked eye, but which may have caused a variation in the breaking strength of the crust. Since the cotton plant breaks the crust from the bottom, all sections of crust were broken from the bottom. The data in Table III show a comparison of resistance to breaking from the top and bottom. Each value represents a single observation at a uniform moisture content.

TABLE III. A Comparison of the Force Required to Break Crust on Cecil Clay from Top and Bottom

Width of crust, cm	Thickness of crust cm	Grams to break crust: Top	Bottom	Modulus of Rupture R: From top	From bottom
1.7	0.6		50		123
1.5	0.7	40		82	
1.5	0.7		57		117
1.5	0.6	30		83	
1.6	0.7		56		108
1.7	0.8	48		68	
1.6	0.6		50		131
1.6	0.7	44		85	

Preliminary Results

It was assumed in this study that the amount of crust formed on soil would depend on climatological conditions, physical and chemical composition, and structure of the soil. Tests in which these conditions were partially controlled or measured were conducted in the laboratory. The results of these tests follow.

Effect of the Amount of Rain on Crust Formation. The data in Table IV show the effect of varying amounts of rain on crust formation. The modulus of rupture in each case is usually the average of twenty-five to thirty breakings for each condition.

TABLE IV. The Effect of the Amount of Rain on Crust Formation

Soil	Modulus of rupture (R) for amounts of rain indicated—average, 25 to 30 breakings: 1/4 in	1/2 in	3/4 in	1 in
Cecil clay B 1/3, sand 2/3	303	360	454	447
Cecil clay B 2/3, sand 1/3	389	392	429	448
Cecil clay B	148	212	239	374
Susquehanna clay*	106	107	178	108
Sumpter clay	500	473	556	613
Houston clay	475	435	810	948
Lufkin clay*	84	98	43	47

*An average of 10 to 15 breakings

The data in Table IV show that the breaking strength of the crust formed in these soils is influenced by the amount of rain. This is graphically shown in Fig. 2. The physical reactions on drying of the Lufkin and Susquehanna clays were such that the true modulus of rupture could not be measured. From Fig. 2 it appears, for the soils with the least hydrated colloids, such as the Cecil, Sumpter, and Houston, that the relationship between rainfall and the force of breaking for each soil follows a general law whose form is, $R = ae^{bx}$, when R is the modulus of rupture, a the intercept constant, b the slope constant, and x the amount of rain in inches. R is proportional to the surface of the fine particles in contact, which is a function of the pore space. The formula states that the rate at which the pore space fills up under the action of water, is proportional to size of pore spaces.

It may be noted that the departure from a straight line, semi-logarithmic relation, was greatest in the case of the soils that have colloids known to be very active and possess marked plasticity and cohesive properties such as the Lufkin and Susquehanna soils. This suggests that other factors such as shrinkage are involved that do not bear a direct relation to the amount of rainfall. The variation in the intercept constants in Fig. 2 may be caused by the variation of several factors such as the state of aggregation, the kind and amount of organic material, and the amount of sand present. These factors were constant only within each soil under the conditions of this experiment.

Effect of the Amount of Moisture in the Crust when Broken. The amount of moisture in the crust at the time of breaking affects the breaking strength. The breaking strength of crust appears to bear an inverse relationship to the moisture within the range studied. Since the crust is a cemented layer of surface soil, the amount of water in the cementative material will determine the hardness of the crust. In soil the cementative material is composed of the finer particles and possibly certain salts that are present.

Effect of Rate of Drying on Crust Formation. The data in Table V indicate that a rapid rate of drying produces a crust with slightly less breaking strength. This seems to be analogous to the setting up of concrete. All other conditions being the same, the strength of concrete depends on the rate at which it is allowed to set up.

TABLE V. The Effect of Rate of Drying on Crust Formation in a Cecil Clay-sand Mixture (Clay 2/3, sand 1/3)

Rain in inches	Hours dried	Modulus of rupture R
1/4	16	425
1/4	116	484
1/2	16	459
1/2	130	562
3/4	16	374
3/4	164	543
1	16	483
1	192	470

Effect of the Chemical Composition of the Soil on Crust Formation. The silica-sesqueoxide ratio of the Lufkin colloid is about 3.8 and that of the Cecil colloid is about 1.5. Anderson and Mattson[e] have shown that clays with low silica-sesqueoxide ratios are less hydrated and more highly flocculated than clays with a high ratio. Baver[4] has shown that there is a relation between size of floccules and the kind and amount of cations held by the absorption complex of the clay, and Bradfield[f] has shown that flocculation of any clay will not take place until there is an excess of cations present in the soil solution above that which is absorbed by the clay.

A few tests were made of crusts from the soils in this study that were saturated with calcium or sodium cations. The soils saturated with sodium produced crusts having a greater modulus of rupture than those saturated with calcium cations. The latter soil crusts were more porous than the former as indicated by apparent specific gravity tests. The soil with the higher apparent specific gravity would have the greater number of fine particles in contact which

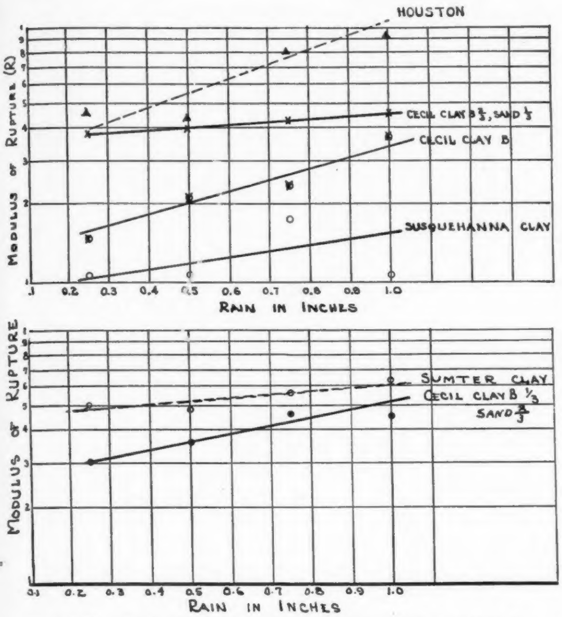


FIG. 2 THE RELATION OF MODULUS OF RUPTURE AND RAINFALL

would account for the greater cementation in the soil. The calcium-treated soil had a greater modulus of rupture than the same soil without any treatment. The effect of varying the salt concentration was not determined.

Difference in the Breaking Strength of Crust on Cotton Beds and in the Middles on a Cecil Clay Soil. Studies were made of natural crusts produced in a field planted to cotton in beds. It was observed that the crusts on the beds were easier to break than those in the middles. The average modulus of rupture on the beds was 322 as compared with 425 in the middles. The concentration of the cementing material in the middles due to drainage probably accounts for the difference.

A Method of Planting Cotton to Help the Plant Break the Crust Formed on Soils. Field observation indicated that when cotton seed was planted in loose soil, there was a tendency for the young plant to double back under the crust or push down in the loose soil instead of breaking the crust. It was also observed that with seed planted in hard ground, all other conditions being equal, there was less difficulty in getting a stand of cotton to break through the crust. Germinating seed and root growth, if confined, will exert forces that will break any crust formed on soils. These observations are in agreement with unpublished field plot data by Diseker[5] at this station. His data indicate the value of soil compaction under the seed in getting a stand of cotton.

Laboratory tests were planned to determine the value of these observations on Cecil clay soil. The factors studied were (1) moisture in the soil at the beginning, (2) compaction of the soil under the seed, and (3) amount of rain. One factor was varied at a time while the others were held constant.

A series of tests, in which five cotton seed were planted 1/2 in deep in pots 6 in in diameter and 6 in high, was conducted. In the first test the soil was placed in the pots without packing and the seed placed and covered 1/2 in deep with loose soil. In three pots prepared in this manner 1/4, 1/2, and 1 in of rain were applied, respectively. In the second test, after the soil had been placed in the pots, pressures of 4, 6, and 10 lb per sq in were applied. The seed was then pressed into the compacted soil and covered loosely to a depth of 1/2 in. Rainfalls of 1/4, 1/2, and 1 in were applied to each of the above pressures. In the third test the moisture in the soil at the beginning was varied. The data in Table VI indicate the value of compaction under the seed in getting a stand of cotton.

The preliminary data in Table VII indicate that the compaction of soil under cotton seed aids materially in getting a stand. Where the per cent of moisture was low (3.00 per cent), with no compaction, the seed germinated but did not come up. With the same moisture, the number of seed that came up increased as the pressure was increased. Pressing the seed into the compacted soil results in a more efficient use of moisture present in the soil, and the compacted soil affords a good footing for the young plant in pushing through the crust. The crust problem, from a practical standpoint, can be solved by proper seedbed preparation before and at the time of planting. The effect of other factors such as temperature and air circulation remain to be solved.

SUMMARY

Methods of studying soil crust were developed. It was found that crusts, very similar to those found in field soils, could be produced in the laboratory by sprinkling with large drops of water. The crusts appeared to be produced by the infiltration of colloids and later cementation of soil particles. The modulus of rupture was used as a measure of crust formation.

The factors affecting crust formation may be summarized in the following manner:

1 The amount of crust formed on a given soil varies with the amount of rain. It appears for the soils with the least hydrated colloids, such as Cecil, Sumpter, and Houston, that the relationship between rainfall and the force of breaking for each soil follow a general law whose form is $R = ae^{bx}$ when R is the modulus of rupture, a the intercept constant, b the slope constant, and x the amount of rain in inches. R is proportional to the surface in contact which is a function of pore space. The formula states that the rate at which the pore space fills up, under the action of water, is proportional to the pore spaces.

2 The rate of drying affects *(Continued on page 171)*

TABLE VI. The Effect of Compacting Soil (Cecil clay B) Under Seed on the Resulting Stand of Cotton

Per cent moisture in soil at start	Rain applied, in	Pressure applied lb sq in	Location of pressure	Number of plants up in varying time in hours: 92	96	120	144	Total per cent of plants up in 168 h
3.00	1	none		0	0	0	0	0
3.00	1	4	under	0	0	2		40
3.00	1	6	under	0	1	2	3	60
3.00	1	10	under	0	1	4		80
9.72	1/2	4	under	2	4			80
9.72	1/2	6	under	3	5			100
9.72	1/2	10	under	3	5			100
16.15	1/4	none		0	1			20
16.15	1/2	none		0	5			100

Keep the Tractor Pulling Its Optimum Load[1]

By A. J. Schwantes[2]

THE OPTIMUM LOAD for a tractor is usually considered to be about 80 per cent of its maximum load[3]. For many farm operations it is easy to supply an optimum load. This is true of such field work as plowing and disking. The power requirement per unit width of plow and disk is usually great enough so that a machine, which will supply an optimum load for the average sized farm tractor, is not too large for practical use on the farm. There are some operations, however, that do not always readily permit loading the tractor to its optimum capacity. Illustrations are harrowing and operating the grain drill, land roller, or pulverizer.

The effects of overload are of a different character than those of loading at less than optimum capacity. Overloading has a serious effect on the tractor itself and thus would be the indirect cause of a high cost per unit of work performed. Operating the tractor at less than optimum load does not affect the tractor seriously, but the practice is responsible for spending more than the necessary time for power, machinery, and labor in performing a given quantity of work. This discussion deals only with tractor operation at less than optimum load in comparison with optimum.

The power and labor cost per unit of work is less when the tractor is loaded to its optimum capacity than it is when only a small load is pulled. It is obvious that more time would be required to disk a 40-acre field when a 7-ft disk is used than would be required with a 10-ft disk. Assuming that the tractor is capable of handling a disk 10 ft wide, the cost per acre for fuel, oil, and other factors of tractor cost is increased when the smaller machine is used. Obviously the cost of labor per acre is also increased, because more time will be required to cover the ground with the 7-ft implement.

For some operations it is not practical to use machines sufficiently large to load the tractor to its optimum capacity. The average three-plow tractor is capable of handling 20 ft of grain drill. Two 10-ft grain drills are not justified on the farm of average size. If, therefore, tractor power is to be used to haul the grain drill which is 10 ft wide, a more profitable load for the tractor may be supplied by hitching the drill in tandem with a harrow, a roller, or a pulverizer.

It is of interest to determine rather definitely to what extent power and labor costs per unit of work done are affected when the tractor is operated at loads less than optimum. To facilitate such a determination the data in Table II were compiled, and from these data the accompanying graph was drawn. The data in Table II were obtained from the results of tests when such results were available. In some cases it was necessary to estimate the effect of varying tractor load upon some of the factors of tractor cost, such as lubricants, repairs, and servicing.

The data in Table I show the average hourly cost of operating two-plow and three-plow tractors. The cost of each of the major factors is shown as well as the proportion that each is of the total. In this discussion we are not interested in the actual cost per hour of operating two-plow and three-plow tractors. We are interested rather in, first, the percentage that each factor of cost is of the total cost, and, secondly, how the cost of each factor per unit of work varies as the tractor load varies.

TABLE I. AVERAGE COST PER HOUR OF TRACTOR OPERATION*

Item	Cost, dollars	Percentage of total cost
Fuel	0.335	28.0
Lubricants	0.080	6.7
Cash repairs	0.060	5.0
Servicing	0.030	2.5
Interest	0.105	8.8
Depreciation	0.240	20.0
Labor (operator)	0.350	29.0

*Schwantes, A. J. and Pond, G. A. The Farm Tractor in Minnesota. Minn. Agr. Expt. Sta. Bull. 280 (1931), p. 31.

The basic data in Table I were obtained from the operators of 300 tractors in various parts of Minnesota. They represent averages of all farm operations, and consequently do not represent actual costs when tractors are used to optimum capacity. However, the costs probably are very near what they would be for tractors on full working load, and the relation of any of the factors to other factors is not much affected by slight load changes.

For purposes of this discussion it is assumed that the total cost per unit of work of operating a tractor at opti-

[1]Approved as Journal Series Paper No. 1241 of the Minnesota Agricultural Experimental Station. Released for first publication in AGRICULTURAL ENGINEERING.

[2]Associate professor of agricultural engineering, University of Minnesota. Mem. A.S.A.E.

[3]Iverson, Geo. W. and others. "Standard Code for Testing Tractors." American Society of Agricultural Engineers Transactions, vol 15 (1921), p. 199.

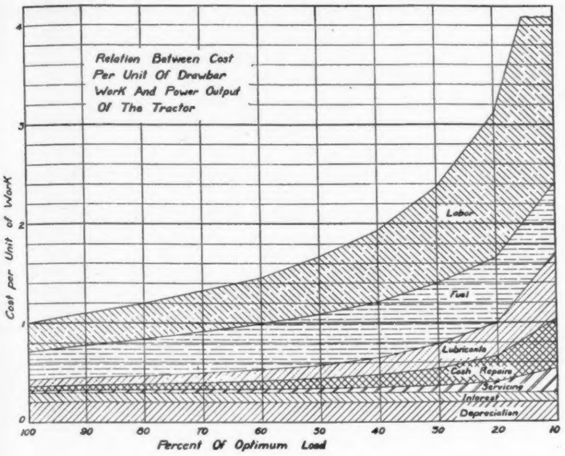
[4]Murdock, H. E. Mechanical Tests on Tractor Farming Equipment. Montana Agr. Exp. Sta. Bull. 243 (1931), p. 40.

[5]Op. cit., p. 43.

[6]The formula used in determining the fuel for each tractor at different loads is $C = Q - aP$. Where C is fuel consumption per horsepower-hour, Q and a are constants which are determined by tests and which vary for different tractors, and P is horsepower developed.

TABLE II. RELATION BETWEEN COST PER UNIT OF DRAWBAR WORK AND POWER OUTPUT OF THE TRACTOR

	Per cent optimum power developed										
Factor of cost	100	90	80	70	60	50	40	30	20	10	0
Fuel	$.280	$.327	$.373	$.421	$.468	$.515	$.562	$.609	$.656	$.703	$.750
Lubricants	.067	.076	.084	.098	.112	.134	.168	.251	.335	.670	
Cash repairs	.050	.056	.063	.071	.083	.100	.125	.167	.250	.500	
Servicing	.025	.028	.031	.036	.042	.050	.063	.083	.125	.250	
Interest	.088	.088	.088	.088	.088	.088	.088	.088	.088	.088	
Depreciation	.200	.200	.200	.200	.200	.200	.200	.200	.200	.200	
Total power	.710	.775	.839	.914	.993	1.087	1.206	1.398	1.654	2.411	
Labor	.290	.322	.362	.414	.483	.580	.725	.967	1.450	2.900	
Power and labor	1.000	1.097	1.201	1:328	1.476	1.667	1.931	2.365	3.104	5.311	



mum capacity is unity, and that the relative magnitude of the factors of cost is as indicated in the second column of Table I.

The work accomplished by the tractor can be measured in horsepower-hours. Since speed as well as drawbar pull is a factor of power, the power delivered by the tractor may be controlled by speed as well as by the size of the implement. This is practicable within the limits of the range in speed at which certain field operations may be performed. Tests that have been made to show the difference in horsepower-hour output per unit quantity of fuel at different speeds, indicate that for some tractors probably there is very little difference and that the difference, except for maximum load, generally can be neglected[4].

In Table II is shown the change in the cost, per unit of work, of each of the factors as the power developed decreases from optimum. The data on fuel are computed from the average results of fuel economy tests conducted on eight tractors ranging in rated drawbar power from 15 to 50 hp[5]. If the fuel consumed per horsepower-hour when the tractor is working at optimum load is represented by 0.28 (which is also the percentage that fuel is of the total cost of tractor operation), the fuel per unit of work when the tractor is developing smaller loads, is indicated by the figures shown in Table II[6]. The fuel consumption per unit of work increases as the power decreases. When the tractor is developing only one-half its rated horsepower, the fuel consumption per unit of work is almost doubled.

When the power output is decreased, the length of time per unit of work increases. It is assumed that the costs of lubricants, repairs, and servicing are in direct proportion to the length of time that the tractor works without regard to the power which is being developed. This probably is not absolutely true. No data are available on this point. No doubt the cost of lubricants and repairs per unit of time that the tractor works would be somewhat higher when the tractor is developing its full power than it would be if only a fraction of the rated horsepower were developed. The increase in these two factors with power developed would be very slight and not nearly in proportion to power. It is felt that the slight injustice which might be done to the use of the tractor at low loads in evaluating these factors is more than compensated for in the evaluation of interest and depreciation at various loads.

In considering the factors of interest and depreciation it is assumed that the life of the tractor is not affected by the number of hours that it is used annually. This is the assumption that is usually made in computing costs of tractors that are operated a normal number of hours. It must be admitted, however, that the life of tractors that are used only a very few hours or a very large number of hours annually is affected by the annual use as well as by age.

The cost of labor per unit of work for operating the tractor must increase as the time increases. Time per unit of work is inversely proportional to the power output of the tractor. For purposes of this comparison the cost of labor is assumed to be 35 cents per hour.

The accompanying graph shows how the cost of power and labor per unit of work vary as the power output of the tractor varies. The rate of increase is not constant, but becomes greater as the power output decreases. The increased cost is small with a slight decrease in the power output but becomes a very significant consideration when the tractor is working only at 50 or 60 per cent of its capacity. In fact, the cost is doubled when only about 38 per cent of the power of the tractor is utilized.

It is not difficult to find a number of farm operations for which the tractor is used at about one-half its rated capacity. Illustrations are the haying operations as they are usually carried on, drilling grain, planting corn, and often the use of the disk harrow and smoothing harrow.

The farm manager is concerned with the problems that are suggested by this analysis in building an optimum load for his tractor. He must take into consideration also the necessity of operating at less than optimum loads for some operations to save the expense of keeping another smaller power unit. He must decide whether it is cheaper to use his tractor at less than optimum load for haying, for instance, than it would be to keep an extra team of horses throughout the year largely for that purpose.

If the tractor is to be used to best advantage, it is important that a size and type be selected in keeping with the farm on which it is to be used. Basic data concerning the relationship between size and type of tractor and such factors as size of farm, type of soil, and type of farming are not now available in sufficient quantity to be of material assistance to the farm operator in choosing the right power unit. It is the responsibility of the agricultural engineer to provide these data in such form as to make them readily usable by the farmer.

Soil Crusts

(Continued from page 169)

the breaking strength of crust. A slow rate of drying produces a crust slightly harder to break.

3 The breaking strength of crust, formed under a given condition, was found to bear an inverse relationship, within the range studied, to the amount of moisture in the crust at the time of breaking.

4 The chemical nature of the soil affects the breaking strength of crust.

5 The modulus of rupture of the crust of soils studied is greater in cotton middles than on ridges.

Preliminary tests indicate that the injury to cotton stands, caused by crust formation, can be solved by the proper preparation of the seedbed before and at the time of planting. Planting cotton on a compacted seedbed affords a firm footing for the young plant in breaking through the crust and results in a more efficient use of moisture present in the soil.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

RESERVOIRS FOR FARM USE, *M. R. Lewis.* U. S. Dept. Agr., Farmers' Bul. 1703 (1933), pp. 11+17, figs. 10. This bulletin supersedes Farmers' Bulletin 828. It describes the construction and maintenance of farm reservoirs to be used for the storage of comparatively small quantities of water.

THE DISCHARGE OF DRAINS SERVING IRRIGATED LANDS, *L. T. Jessup,* U. S. Dept. Agr., Bur. Agr. Engin., 1933, pp. 8, fig. 1. Data relative to the maximum discharge of several drainage systems serving irrigated lands in 13 western states are presented and discussed.

These projects have an aggregate gross area of approximately 2,850 sq mi, of which 2,100 sq mi are irrigated. They contain a total of 2,550 mi of drain and 230 drainage wells. Data are also presented on the total annual run-off from a gross area of 1,642,000 acres, of which 1,214,000 acres are irrigated. For most of this latter area the relation between annual run-off and total water applied is shown.

A summary giving total area and miles of drain for the various districts considered and weighted averages for all other factors showed that for a group of districts having an aggregate irrigated area of 1,113,646 acres the annual drain yield is 30.9 per cent of the total water applied, and that 74.2 per cent of the annual yield is carried during the period from April to October, inclusive. It shows also that the annual yield is 1.84 acre-feet per acre, that the main irrigation system losses are 1.94 acre-feet per acre, that the sum of the water delivered to the land and precipitation is 4.01 acre-feet per acre, and that the difference between total water applied and drainage yield is 4.11 acre-feet per acre.

Data on the maximum monthly rate of drain yield per square mile of tributary irrigated area and per linear mile of drain for each class of formation considered show that the range of limits for each class is wide, partly because of difficulties of classification and of variation in permeability, but to a large extent because of variation in many other factors that influence the rate of yield.

INFLUENCE OF ELECRIC CURRENT ON SOIL FIRMNESS [trans. title], *N. Puchner.* Fortschr. Landw., vol. 8 (1933), no. 17, pp. 385-388, figs. 8. Studies conducted at the Technical Academy of Munchen on the influence of an electric current at 110-v pressure on the cohesive properties of soil as they resist the passage of tillage implements through the soil are reported. The soils tested were medium and heavy clay loams, and the experimental set-up simulated an arrangement whereby the plowshare is the negative pole. A current of 0.5 a was used.

It was established that the resulting decrease in draft power requirement is not due solely to electro-endosmose but mainly to a change and reduction in internal friction of the soil. It was found that the elasticity under pressure and the cohesion of a soil mass could be markedly decreased by passage of an electric current. This effect was even more marked in the heavy loam soil than in the medium loam soil. Within the moisture content limits of from 13 to 15 per cent and at a decreasing water content there was a linear increase in the compaction of a medium loam soil under pressure. The compaction decreased from 12 to 15 per cent under the influence of a current of 0.5 a at 110 v. Under the same conditions the compaction of a heavy loam soil decreased from 25 to 35 per cent.

SOIL MECHANICS IN ENGINEERING: I, Soil Types and Properties; II, Permeability; III, Consolidation, *J. Mulholland.* Commonwealth Engin., vol. 20 (1933), no. 7, pp. 185-192, figs. 13; no. 8, pp. 225-231, figs. 10; no. 9, pp. 259-266, figs. 13. This series of three articles sets forth some applications of the developing science of soil mechanics to practical problems in engineering design and construction.

In the first article, which deals with soil types and properties, examples are given of the general use of soil mechanics in engineering. The second article, dealing with the mechanics of permeability and the measurement of permeability, demonstrates the importance of this feature in structures such as earth dams. The final article deals with the factors affecting the consolidation of soils and with methods for its measurement. Examples are given of the effects of consolidation of soils, and the theory of consolidation is discussed.

THE DESIGN, CONSTRUCTION, AND TESTING OF CREAM SEPARATORS [trans. title], *W. Fritz* and *U. Mennicke.* Schr. Reichskurator. Tech. Landw., no. 34 (1932), pp. 54, figs. 83. The first part of this publication discusses the important technical features involved in the construction of cream separators. The second part is a mathematical analysis of the process of cream separation as it occurs in the modern cream separators. The third part relates to the testing of the mathematical formulas underlying the design of cream separators as a basis for a standard testing procedure to determine the separating efficiencies of cream separators.

DETERMINATION OF SOME PHYSICAL CHARACTERISTICS OF DETONATION [trans. title], *M. Serruys.* Compt. Rend. Acad. Sci. (Paris), vol. 195 (1932), no. 25, pp. 1228-1230, fig. 1. The conclusion is drawn that detonation is a local phenomenon of duration between 1/10,000 and 1/20,000 of a second, and is produced at the end of combustion when nearly all the available heat has been utilized. The findings indicate that pressures which double or treble the normal may accompany detonation, according to its intensity, and may even exceed 100 kg per square centimeter (about 1,450 lb per square inch).

APPLYING VISCOSITY INDEX TO SOLUTION OF LUBRICATING PROBLEMS, *G. H. B. Davis, M. Lapeyhouse,* and *E. W. Dean.* Oil and Gas Jour., vol. 30 (1932), no. 46, pp. 92, 93, 169, figs. 5. In this article a compilation of the more useful data and charts on viscosity index is given. A discussion of the application of viscosity index to lubricating problems is also included. In this it is indicated that the viscosity index of an oil has a direct bearing on (1) ease of cold weather starting and (2) oil consumption in the engine.

PORTABLE REFRIGERATION CHAMBERS FOR STUDYING COLD RESISTANCE OF PLANTS IN THE FIELD, *J. R. Holbert, W. L. Burlison,* and *A. G. Johnson.* U. S. Dept. Agr. Circ. 285 (1933), pp. 28, figs. 23. Portable refrigeration chambers in which corn plants growing under natural conditions in the soil may be exposed to various temperatures for different periods are described and illustrated and their operation explained.

In general, each chamber consists of a specially constructed refrigerator box open at the bottom so that it can be set down over the plants. The walls and top are heavily insulated with cork, sealed in with hydrolene, and covered inside and outside with thick composition board (homosote). The top is covered with galvanized iron. All is kept heavily painted, both inside and outside. Specially designed equalizers to which the hoists are attached are used on two sides of the chamber for raising or lowering it. Four electric refrigeration units are mounted on one side of the chamber. These refrigeration units have a combined refrigeration capacity equivalent to approximately 1,600 lb of melting ice in 24 h. The work involved was conducted in cooperation with the Illinois Agricultural Experiment Station.

SEWAGE DISPOSAL ON THE FARM, *M. C. Burt.* Farming in So. Africa, vol. 8 (1933), no. 90, pp. 349, 350, figs. 4. Practical information is given on the planning and installation of small sewage disposal systems adaptable to farms in South Africa. The systems described consist of septic tank and tile absorption area for effluent disposal. The paper is a contribution from the Stellenbesch-Elsenburg College of Agriculture.

LUBRICANTS AND LUBRICATION, *A. R. Bowen.* Jour. Inst. Petroleum Technol., vol. 19 (1933), no. 117, pp. 578-591. In a contribution from the University of Birmingham, England, a brief review is presented of the advances made recently in the development of lubricants and lubrication practices.

GASOLINE ENGINES AND KNOCK TESTING, *R. Stansfield.* Jour. Inst. Petroleum Technol., vol. 19 (1933), no. 117, pp. 567-573. A brief summary is given of progress in the development of automotive internal-combustion engines and of knock testing, using the CFR (Cooperative Fuel Research) technic.

LOCALIZATION OF THE PHENOMENON OF DETONATION [trans. title], *M. Serruys.* Compt. Rend. Acad. Sci. (Paris), vol. 195 (1932), no. 26, pp. 1376-1379, figs. 3. Experiments are reported, the purpose of which was to determine the actual seat of detonation. An air-cooled engine was equipped with 17 thermo-electric couples in the wall for this purpose.

It was found that in the presence of detonation the temperature raises at certain points more than 100 deg C, while at other points the increase is not more than 20 deg. In the absence of detonation this variation in temperature is not observed. Photographs and diagrams of the ends of pistons show erosion and fractures which occur in the regions where the abnormal temperature increases were observed.

The conclusion is drawn that these points are the actual locations where detonation occurs.

MEASUREMENT OF SPEED OF HEAT PRODUCTION IN THE CYCLE OF AN INTERNAL-COMBUSTION ENGINE BY THE USE OF INDICATOR DIAGRAMS [trans. title], *T. Te-Lou.* Compt. Rend. Acad. Sci. (Paris), vol. 196 (1933), no. 5, pp. 329-332, fig. 1. In experiments on the phenomena of the development of active combustion in an internal-combustion engine, graphic data are deduced showing the variation of the ratio of heat production to time, thus giving the speed of contribution of heat in the cycle. The curve at first increases rapidly, then flattens out, and finally decreases rapidly.

It was found that the speed of flame propagation in the engine is proportional to the speed of the engine, which was varied from 500 to 1,250 rpm in the experiments. This is attributed to the increase in turbulence of the gas as the engine speed increases.

THE EFFICIENCY OF SURFACE TREATMENTS ON THE PERMEABILITY OF CONCRETE, *G. W. Washa.* Jour. Amer. Concrete Inst., vol. 5 (1933), no. 1, pp. 1-8, figs. 3. The results of tests conducted at the University of Wisconsin are reported in which an effort was made to ascertain the merits of some of the commonly used surface waterproofing compounds.

The treatments were divided into seven different classes including (1) treatments consisting of water solutions of inorganic salts which react chemically with the constituents in the concrete with a subsequent deposition of insoluble material in the pores of the concrete; (2) water suspensions of substances or mixtures of substances of a pore-filling character or which react chemically with each other or with constituents in the concrete and form pore-filling compounds; (3) soaps; (4) combinations of solutions, in two or more applications, which react chemically with each other in the pores of the concrete, filling them with substances of a water repellent or insoluble nature; (5) solutions of liquid and solid hydrocarbons consisting of heavy petroleum distillates such as lubricating oil or paraffin dissolved in volatile solvents such as gasoline, the solid matter being deposited in the pores of the concrete upon evaporation of the solvent; (6) bituminous coatings and membranous systems which tend to produce films or membranes over the surface of the concrete; and (7) miscellaneous washes and cement grouts.

The use of surface treatments to obtain lower leakages through concrete was more or less beneficial in all cases. The value of the various treatments, however, varied widely, with some treatments giving an efficiency of around 40 per cent and others giving efficiencies very close to 90 per cent. The efficiency of the treatment depended upon the compound used and also on the method of application. That is, a compound properly applied giving good results might give very poor results if improperly applied. Also the efficiency is dependent more on the individual treatment used than on any class of treatment.

Some of the more effective types of treatments according to these tests are 1:1 grout properly cured, Minwax, 1:2 grout properly cured, neat cement properly cured, plain asphalt emulsion, Glidden, Sika grouts, Por-seal "A", casein, and sodium silicate. The rate of leakage through the specimen for the 20 to 50-h period is practically the same as the rate for the 40 to 50-h period.

If cement grouts are to be used they should be moist cured for at least a week to obtain the best results. Tests showed that the efficiency of a 1:1 grout was reduced from 88 to 45 per cent by decreasing the moist curing period from 7 to 0 days. The 1:1 grout cured for 7 days gave an efficiency of 88 per cent which was the best of any of the grouts tested. With the leaner 1:2 grout the efficiency was 72 per cent, and with neat cement it was only 65 per cent.

Exposure to the elements decreased the efficiency of all treatments tested with the exception of the sodium sulfate plus barium chloride treatment. The decrease in efficiency caused by an exposure of two years varied from 5 to about 80 per cent, based on original efficiency. The treatment which was an exception to the general trend increased its efficiency about 70 per cent, also based on original efficiency.

PROCEDURE FOR MAKING DRAFT TESTS OF PLOWS, DIRECTIONS FOR MAKING SQUARE YARD HARVESTS OF LEGUMES, AND DESCRIPTIONS AND USE OF SOIL SAMPLING TUBE. U. S. Dept. Agr., Bur. Agr. Engin., 1933, pp. 21, figs. 3. Suggestions for making draft tests of plows and plowing equipment are given which are the outgrowth of a series of conferences held in Ohio during 1932 between members of the staff of the division of mechanical equipment, U.S.D.A. Bureau of Agricultural Engineering and of the departments of agricultural engineering, agronomy, and district and county experiment farms of the Ohio Agricultural Experiment Station. The method of procedure was developed in an effort to make possible the correlation of the data obtained in draft tests at different locations and by different individuals in the State. The procedure involves both field and laboratory observations, including in the latter particularly the determination of the plasticity characteristics. The list of references omits the reports of voluminous work done on this subject at the Alabama Agricultural Experiment Station.

Directions also are given for making square yard harvests of legumes, and a soil sampling tube is described and illustrated which has been found convenient for rough sampling for moisture and apparent specific gravity determinations. The tube was developed by the U.S.D.A. Bureau of Agricultural Engineering.

A NEW SYSTEM OF LAND CULTIVATION. Impl. and Mach. Rev., London, vol. 59 (1933), no. 702, pp. 478-481, figs. 4. The Pelo Pardi system of land cultivation is briefly described, and the equipment used is illustrated.

This system is based on the principle of subdividing the land into units of cultivation, each one controlling its own regime of water. Every unit is limited by the line of impluvium and displuvium, and therefore constitutes a zone of earth having a single slope. In its turn, each unit is subdivided into smaller sections that are 10 m wide and consist of two gently sloping sides that join in the middle at the peak and at their lower ends adjoin similar subdivisions of the same unit of cultivation. All these subdivisions as a unit are in turn together surrounded by what are special types of headland, something like 5 m wide, the headlands at the top and bottom of the inclination of the unit of cultivation, and also the ones running longitudinally, having a special furrow cut between them and the unit of cultivation they surround.

The important part is that the configuration of the superstructure is exactly reproduced in the subsoil, which is to say that the plane of the bottom of the worked earth has a course constantly parallel to that of the plane of the superstructure.

EXPLOSIVES AND AGRICULTURE [trans. title], *A. Piedallu.* Ann. Agron. (Paris), n. ser., vol. 2 (1932), no. 3, pp. 384-396, figs. 4. Experiences on the use of explosives for stone and boulder removal, hardpan breaking, drainage, tree planting, and the like are described briefly. The author points out that nitrate explosives only should be used for agricultural blasting. A variable mixture of trinitrophenol, nitronaphthaline, and trinitrotoluene is considered to be the best agricultural explosive in that it has both a physical and a chemical effect on the soil. It liberates carbon monoxide which destroys animal life in the soil, and also liberates oxygen which stimulates nitrification.

VENTILATION OF DAIRY BARNS IN QUEBEC, *L. G. Heimpel.* Sci. Agr., vol. 13 (1933), no. 8, pp. 528-539, figs. 4. A comparative study of 14 barns having seven each of two types of ventilation systems is reported in a contribution from Macdonald College of Quebec. The purposes of the study were (1) to discover and measure any differences in effectiveness and operation between the King and Rutherford types of ventilation systems, and (2) to collect data needed in the improvement of construction of dairy barns and their ventilation systems.

Observations were made of outtake air velocities, relative humidity, temperatures, and wind velocities. The data indicate that both the King and Rutherford types of ventilation are effective in bringing about a sufficiently rapid rate of air change to produce good stable conditions. Stable conditions which must be described as good and mediocre can be found among both types of installations, but in cases of failure or partial failure the cause is usually one of the following conditions or a combination of two or more of them: (1) Insufficient flue capacity, (2) too high a cubic content per animal unit or understocking of the stable, (3) lack of insulation in walls and ceilings to permit maintaining of the necessary temperature difference for good stable conditions in cold weather, and (4) air leakage through walls and ceilings and failure to equip stable with double doors and windows.

It was found that outtake facilities can be concentrated to good advantage in a single flue. This is true *(Continued on page 182)*

AGRICULTURAL ENGINEERING

Established 1920

A journal devoted to the advancement of the theory and practice of engineering as applied to agriculture and of the allied arts and sciences. Published monthly by the American Society of Agricultural Engineers, under the direction of the Publications Committee.

PUBLICATIONS COMMITTEE

JAMES A. KING, Chairman

H. B. WALKER R. U. BLASINGAME

W. G. KAIZER L. J. FLETCHER

The Society is not responsible for the statements and opinions contained in the papers and discussions published in this journal. They represent the views of the individuals to whom they are credited and are not binding on the Society as a whole.

Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

Original articles, papers, discussions, and reports may be reprinted from this publication, provided proper credit is given.

RAYMOND OLNEY, Editor

R. A. PALMER, Associate Editor

The Engineer as Counsel at Large

DISTINGUISHED members of other engineering societies and Secretary of Agriculture Wallace have been quoted in these columns as spokesmen for a growing feeling that the engineer, by sheer force of his qualifications, has a public trust. The society which trained him, which maintains the civilization that supports him, has a right to expect from him candid appraisal and constructive economic criticism of all public projects and policies having an engineering content.

Our own Society president, Arthur Huntington, in a recent address excerpted elsewhere in these pages, does more than bind this burden of social obligation more firmly on the shoulders of the engineer, agricultural or otherwise. He makes it plain that each engineer must discharge this duty to keep the good name, both of himself and of engineering as a profession.

In the American scene, where we are wont to over-organize, where we have faith in slogans, systems, and formulas, not to mention the tidal wave of codes, there will be temptation to meet this challenge by the obvious expedient of drafting a clause for insertion in a formal code of ethics. Vision and strength will be needed to resist this temptation.

Survival of the quack and the shyster despite ethical systems established for centuries is proof enough that codes have their limitations. Yet it is not occasional violation of the code which forms its objection for our present purpose. The obligation of the engineer to the public and to the good name of his profession is so complex, so intangible, as to defy complete definition. To draw an indictment for its violation would be impossible except in flagrant cases. We do not want an arrangement which merely separates sheep and goats on the border-line of flagrant cases.

We believe that this issue is akin to the thing called intellectual honesty, for lack of which no man ever went to prison. In our judgment the social honesty of the engineer will best be established by emphasizing his personal responsibility for work done and opinions rendered. Professional loyalty need not and should not prevent fair, keen criticism of the work done by others. With social responsibility a recognized ideal of all engineers it will be duly considered in the informal ranking of an engineer, or firm of engineers.

Our aim, of course, is to bring all engineers to a uniformly high ethical standard. The surest way to that end is not by silent assent to the loose assumption that engineers are pretty much alike, but by giving honor to our colleagues in such measure as they have earned, both as technicians and as citizens. Formal awards by our Society and by other engineering bodies are but gestures, symbolic of the discrimination with which we should appraise activity throughout the profession.

As we in the profession rate our brethren and ourselves more and more in terms of citizenship, so will the citizenry at large look more and more to the standing of the engineer who makes a report, recommendation, or criticism, and value his utterance accordingly. That way lies greater prestige for the profession.

Labor-Saving: A Misnomer

"WHEN WE USE the term 'labor-saving machinery,' I think that we are losing sight of a psychological effect. I have adopted the term 'labor-adjusting machinery' as being more descriptive," remarks a member of the American Society of Agricultural Engineers in writing to the editor. "In agriculture (for example) we eliminate much of the floating harvest labor by providing year-round jobs for men in factories producing the harvesting machinery."

This engineer is a man of mature judgment with well-rounded experience in both the educational and industrial wings of the profession. In both capacities he has observed not only the economics involved, but human reaction to the term "labor-saving." His suggestion deserves serious consideration in a time when the social wisdom of highly evolved machinery is questioned by a thoughtful few and denied by the thoughtless many.

Nearly fifteen years ago, at the height of the post-war tractor boom, another member of the Society advanced the same idea, though labor-saving was then as much in demand as it has been lately in question. Then and now highly esteemed as an economic thinker, he contended that the tractor (admittedly not so well perfected as now) saved little or no labor above that consumed in its manufacture and the production, transportation, etc., of its component materials. He argued that the tractor merely shifted labor from farm to factory and mine.

More recently he has voiced the opinion that labor-saving machinery, so-called, in sum total creates as much or more employment than it destroys, its net social benefit appearing as improved conditions of labor and increased consumer-value in the product thereof. However, much labor may be displaced in a specific operation; it is cancelled by the creation of jobs elsewhere in the body politic, resulting ultimately not in depression of employment, but in elevation of living standards.

Though we know of no surveys sufficiently comprehensive to prove it statistically, we surmise that if the investment, operating, and maintenance costs of labor-saving equipment were completely broken down to reveal their labor component, and this figure compared with the direct labor displacement during its useful life, we would find some net reduction in labor, but that it would be materially less than the labor diversion. So, even ignoring the indirect creation of new employment, labor diversion would have a stronger claim than labor saving on our nomenclature.

Whether "labor-adjusting" is the happiest term for this revised concept is not so sure. Classically derived, it is accurate enough in its mere denotation. But for color of connotation and vigor of suggestion it may be better to look for some rugged monosyllabic root from the Anglo-Saxon or kindred tongue. Not in a spirit of dictation, but as something to be bettered if may be, we suggest the word "shift" and the phrase "labor-shifting." While "shift" suggests mainly transfer or diversion, its precise meaning also admits the sense of riddance.

Whatever term be chosen, now is the time to do it, while the winds of popular emotion blow cold on the implications of "labor-saving."

The 1934 McCormick Medal Award

MARK LOVEL NICHOLS of Alabama Polytechnic Institute has been chosen by the Jury of Awards of the American Society of Agricultural Engineers to receive the Cyrus Hall McCormick Medal for 1934. Formal presentation of the medal will be made at the annual meeting of the Society at Detroit, June 18, 19, and 20.

The meaning of this award appears in an inscription on the medal itself: "For Exceptional and Meritorious Engineering Achievement in Agriculture." Even more significant than their creation of the permanent endowment trust which provides the intrinsically valuable medals is the purpose of three members of the McCormick family — Mr. Cyrus H. McCormick, Mrs. Emmons Blaine, and Mr. Harold F. McCormick—to project the spirit of their father, Cyrus Hall McCormick, inventor of the reaper, among the men who today seek to lighten the burdens and enlarge the fruits of agriculture.


MARK LOVEL NICHOLS

Although this is an annual award, its bestowal implies no special emphasis on work of the immediately preceding year; rather it denotes such achievement as to distinguish a whole career, and to make enduring contribution to the age-old art of agriculture. Professor Nichols has attained this distinction at a comparatively early age, and the dozen years of his major contribution are short beside the complexity of its content and the period through which it promises to guide the methods and mechanics of soil manipulation.

Born near Bellevue, Ohio, Mark Lovel Nichols was graduated from the Bellevue high school and took his bachelor's degree from Ohio State University in 1912. Later, while instructor in agricultural engineering in the agricultural college, he pursued advanced studies which brought him a master's degree in 1918 from Delaware University.

Besides three years as a farmer his professional activity includes service in the experimental department of the Ohio Cultivator Company; teaching in the T. N. Vail Agricultural School at Lyndonville, Vermont; and employment as a tractor specialist by a branch house of the International Harvester Company. As extension specialist in agricultural engineering of Virginia Polytechnic Institute, following his work at Delaware University, he had a considerable part in developing agricultural engineering activity in Virginia.

Since 1919 Professor Nichols has been with the Alabama Polytechnic Institute, at Auburn, where he is head of the department of agricultural engineering, sharing activity in teaching and extension work, though more of his effort is devoted to research in the associated Alabama Agricultural Experiment Station. During most of this period he has been carrying on the fundamental studies of soil dynamics which have earned him renown as an international authority.

Papers embodying his findings have appeared from time to time in AGRICULTURAL ENGINEERING over a period of years. These papers, some of which were presented in person at technical meetings of the Society, are acclaimed by men high in research circles as reflecting what they deem the most outstanding single example of pure research in agricultural engineering during the history of the profession. Besides the magnitude of the work and its high rank as physics and mathematics, its basic value to the art of soil tillage carried much weight with the A.S.A.E. Jury of Awards in selecting him as this year's McCormick Medalist.

Professor Nichols became a member of the American Society of Agricultural Engineers in 1918. He has been chairman or member of the Research Committee for a number of years; was the first chairman of the Southern Section; and at present is first vice-president of the Society. An inkling of the esteem in which he is held in the profession, and of the activities to which his research brings authority, is given by the circumstance that he now is also a member of the Advisory Council (to the Bureau of Agricultural Engineering, U. S. Department of Agriculture) on Farm Machinery Research; and of the committees on Materials for Agricultural Machines and Soil Preparation and Tillage, respectively, in the Power and Machinery Division of the A.S.A.E.

In addition to authorship of sundry bulletins and articles in scientific and agricultural publications, Professor Nichols with one of his colleagues was a contributor to the Proceedings of the International Soil Congress at Leningrad in 1930.

* * * * *

The selection of Professor Nichols to receive this year's award of the Cyrus Hall McCormick Medal will be enthusiastically received by the agricultural engineering profession. His original work in soil dynamics at the Alabama station is so widely known and its outstanding value and significance so generally recognized, that his selection will be acclaimed with widespread approval. The Society's Jury of Awards which named Professor Nichols as the 1934 McCormick medalist, consisted of the seven immediate past-presidents: C. E. Seitz (chairman), L. J. Fletcher, R. W. Trullinger, W. G. Kaiser, Wm. Boss, O. B. Zimmerman, and O. W. Sjogren.

NEWS

New 1934-35 A.S.A.E. Officers

AS A RESULT of the annual election of officers of the American Society of Agricultural Engineers recently, the new officers chosen to take office following the 28th annual meeting of the Society to be held at Hotel Detroit-Leland, Detroit, Michigan, June 18, 19, and 20, are as follows: President, Glenn William McCuen, professor of agricultural engineering and head of the department, Ohio State University; First Vice-President, Deane G. Carter, professor of agricultural engineering and head of the department, University of Arkansas; Second Vice President, A. W. Lavers, chief engineer, tractor division, Minneapolis-Moline Power Implement Company; Councilor, R. H. Driftmier, professor of agricultural engineering and head of the department, University of Georgia. The secretary of the Society, Raymond Olney, was reelected Treasurer.

The new Council of the Society for the year 1934-35 includes the above-named officers, together with Hobart Beresford and E. E. Brackett, Councilors; C. E. Seitz, Senior Past-President, and Arthur Huntington, retiring President. The newly elected Nominating Committee consists of Daniels Scoates (chairman), H. B. Walker, and R. W. Trullinger.

Pacific Coast Section to Contribute to Joint Program

THE Pacific Coast Section of the American Society of Agricultural Engineers will cooperate with the Hydraulic Section of the American Society of Mechanical Engineers and the Hydrology Section of the American Geophysical Union in presenting a joint program devoted to the general topic of "Fluid Mechanics," at a meeting to be held on the campus of the University of California, Berkeley, June 20 and 21. Several A.S.A.E. members will contribute technical papers and discussions to this program.

During the week beginning June 18 will be held the annual meeting of the American Association for the Advancement of Science at the University of California. This meeting and the others named in the foregoing paragraph will attract a large number of scientists from all over the United States.

Home Economics Meeting in June

THE twenty-seventh annual meeting of the American Home Economics Association will be held in New York City, June 25 to 29, 1934, with the Hotel Pennsylvania as headquarters.

The central theme, "The Consumer in the New Economic Order," will be discussed by representatives of industry, business, government agencies, and consumer groups as well as by members of the Association.

There will be two public meetings addressed by speakers of national importance. The first of these will be at 8:30 p.m. on Tuesday, June 26, with Miss Frances Zuill of the University of Iowa, president of the Association, in the chair. Miss Anna Cooley of Teachers College, Columbia University will preside at the second public meeting on Wednesday, June 27, at 2:00 p.m.

Family relationships, family economics, the house and its management, food and nutrition, textiles and clothing are special divisions of home economics to which group meetings will be devoted. There will also be opportunity for members to discuss home economics progress and plans in such different occupations as teaching, extension service, business, institution administration, homemaking, research, and social service.

The business of the Association will be transacted at the annual business session and at meetings of the Council.

Permanent headquarters of the Association are at 622 Mills Building, Washington, D. C.

Construction Details for Hay Equipment

THOSE agricultural engineers who were interested in the model hay chute, exhibited by the Pennsylvania State College agricultural extension service at Purdue University last summer, will be glad to know that drawings have been published giving some of the dimensions and construction details. This is not a new idea, as some of the first ones have been in use over 40 years, but, due to the inaccessibility of the locality where it was developed, there has been little spread of the idea. It was originally taken up by the Pennsylvania agricultural extension service as a means of preventing hay packing under the hay fork, and thus providing a seat for spontaneous combustion. However, it is also a labor saver in the tiresome job of mowing away hay.

Another sheet, which is issued, shows two types of the "one man hay rack." There are at least five different versions of the same idea in Pennsylvania, but all of them are based on the one idea of loading the back end of the hay rig with the loader and then sliding the movable carriage forward with half the load on it. The hay for the back end is then loaded directly on the frame.

Two other sheets show different types of barn framing. These were also issued at the same time.

Construction details on these items can be obtained by addressing John R. Haswell, Agricultural Extension Service, Pennsylvania State College, at State College.

Personals

M. A. R. Kelley, agricultural engineer, division of structures, Bureau of Agricultural Engineering, U. S. Department of Agriculture, is one of the authors of an article, entitled "Estimated Data on the Energy, Gaseous, and Water Metabolism of Poultry for Use in Planning the Ventilation of Poultry Houses," which appeared in the Journal of Agricultural Research for November 15, 1933.

L. M. Kishlar has recently been appointed manager of research of the Purina Mills (Ralston Purina Company). The chemical, biological, cereal, and pathological laboratories of this concern are located at St. Louis, and the Purina Experimental Farm is located at Grays Summit, Missouri.

J. P. Schaenzer has been appointed agricultural and irrigation engineer of the National Power Survey of the Federal Power Commission. His new address is in care of the Commission at Washington. He was formerly project director in rural electrification in the agricultural engineering department, University of Wisconsin.

N. W. Wilson has recently been appointed to the position of agricultural engineer of the Alabama project of the Soil Erosion Service, U. S. Department of the Interior. He was formerly connected with the agricultural engineering department at the Alabama Polytechnic Institute.

C. E. Wise, Jr. was recently elected secretary of the Maryland State Farm Bureau, having previously been employed as extension specialist in agricultural engineeering for the University of Maryland.

New ASAE Members

Don Critchfield, trade promotion, Lead Industries Association. (Mail) 2535 P. St., Lincoln, Nebr.

John A. Schaller, senior engineer, Erosion Control Division, Emergency Conservation Administration. (Mail) Barneveld, Wis.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the April issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

F. M. Bozarth, concrete inspector, Grade "A", Kansas State Highway Commission, Topeka, Kansas.

Clarence F. Kelly, state foreman, Illinois Department of Conservation. (Mail) Camp 63-P, Herod, Illinois.

N. B. Morgan, manager of seed corn department, Morgan Brothers, RFD 1, Galva, Illinois.

PRELIMINARY PROGRAM

28th Annual Meeting of the American Society of Agricultural Engineers
Hotel Detroit-Leland, Detroit, Michigan - June 18, 19 and 20, 1934

First Day - Monday, June 18

Forenoon Programs (Three) - 9:00 to 12:00

(A) COLLEGE DIVISION
G. W. McCuen, chairman, presiding

1 COMMITTEE REPORTS (5 min each)
2 ADDRESS: "Responsible Self-Direction" — M. R. Keyworth, superintendent of public schools, Hamtramck (Michigan)
3 ADDRESS: "Effective Measurement of Progress of Students"—Ralph W. Tyler, bureau of educational research, Ohio State University

(B) COMMITTEE ON EXTENSION
Earl G. Welch, general chairman, presiding

1 PAPER: "The Relation of CCC Erosion Control Work to Agricultural Engineering Extension" — Virgil Overholt, agricultural engineer, Ohio State University
2 PAPER: "A Farm Machinery Extension Program"—G. O. Hill, Purdue University
Discussion led by E. G. Johnson, extension agricultural engineer, University of Illinois
3 PAPER: "Planning Agricultural Engineering Extension Work in the Light of the AAA Program" — H. W. Hochbaum, Agricultural Extension Service, U. S. Department of Agriculture

(C) AGRICULTURAL ENGINEERING STUDENTS' CONFERENCE
Henry A. Collin, Jr., president, presiding

1 President's Greeting—Mr. Collin
2 Greetings from President Arthur Huntington and President-Elect G. W. McCuen of A.S.A.E.
3 Reports from A.S.A.E. Student Branches—By representatives of the branches attending the meeting
4 Presentation of Three Winning Papers in the 1934 A.S.A.E. Student Papers' Competition—By the winners in person
5 PAPER: "Fields of Opportunity for Agricultural Engineers" — James B. Stere, student in agricultural engineering, Pennsylvania State College
6 DISCUSSION: Ideas for Student Branch Activities and Meeting Programs—Led by R. C. Miller, chairman, A.S.A.E. Committee on Student Branches

Afternoon Programs (Two) - 2:00 to 5:00

(A) LAND RECLAMATION DIVISION
Lewis A. Jones, vice-chairman, presiding

1 PAPER: "A Method of Evaluating the Soil Factor in Land Appraisals"—R. Earl Storie, associate in soil technology and survey, University of California
2 PAPER: "Present Policies of the Agricultural Credit Administration with Reference to Irrigation and Drainage in Connection with Federal Land Bank Loans"—W. R. Parkhill, chief engineer appraiser, Agricultural Credit Administration
3 PAPER: "Appraisals of Drainage Districts by Federal Land Banks"—E. G. Johnson, extension agricultural engineer, University of Illinois
4 PAPER: "Refinancing of Drainage Districts" — Emil Schram, chief of drainage, irrigation, and levee division, Reconstruction Finance Corporation
5 PAPER: "Irrigation Needs of Humid Sections" — F. E. Staebner, associate drainage engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture
6 PAPER: "Spacing and Depth of Tile Drains"—J. H. Neal, agricultural engineer, University of Minnesota

(B) RURAL ELECTRIC DIVISION
Richard Boonstra, chairman, presiding

1 PAPER: "Electric Lighting and Its Application to Rural Areas"—W. C. Brown, illuminating engineer, Nela Park Engineering Department, General Electric Company
2 PAPER: "Electrical Equipment and Its Application to Farm Uses"—(speaker to be selected)
3 PAPER: "Electrical Equipment in the Farm Home" —Miss Gail M. Redfield, research assistant in home economics, Purdue University
4 Summary of Afternoon Program—
(a) E. W. Lehmann, professor of agricultural engineering, University of Illinois
(b) T. E. Hienton, project leader in farm electrification, Purdue University

Evening Programs

(A) 8:00—Council Meeting
(B) 7:00—Agricultural Engineering Students' Conference—Dinner and Business Session
(C) Committee on Extension—Dinner and Roundtable

(D) 8:00—RURAL ELECTRIC DIVISION
Richard Boonstra, chairman, presiding

1 PAPER: "Federal Projects Involving Rural Electrification"—R. W. Trullinger, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture
2 PAPER: "Characteristics of Small Atmospheric Cooling Towers for Dairy Barns"—R. L. Perry, agricultural engineering, University of California

(E) 8:00—POWER AND MACHINERY DIVISION ROUNDTABLE
A. W. Lavers, vice-chairman, presiding

1 "Tractor Engine Problems in Farm Service"—Led by C. G. Krieger, agricultural engineer, Ethyl Gasoline Corporation
2 "Engine Fuels to Meet Farm Requirements"—Led by Wm. Harrigan, supervisor, manufacturers' service, The Texas Company
3 "Rubber Tires for Farm Equipment Applications"—Led by H. W. Delzell, manager, technical service, tire division, B. F. Goodrich Company
4 "Progress in Combine Development"—Led by I. D. Mayer, agricultural engineer in experiment station, Purdue University

Second Day - Tuesday, June 19

Forenoon Program - 9:30 to 11:30

PRESIDENT ARTHUR HUNTINGTON presiding

1 Call to Order—H. H. Musselman, chairman, Committee on Arrangements

2 PRESIDENT'S ANNUAL ADDRESS—Arthur Huntington, public relations engineer, Iowa Electric Light and Power Company

3 ADDRESS: "Responsibilities of Agricultural Engineers in Agricultural Reorganization"—W. R. Woolrich, chief, general industry and mechanical research division, Tennessee Valley Authority

4 PAPER: "The Function of Agricultural Engineering Research in the Land Grant Colleges"—M. L. Nichols (1934 McCormick Medalist), professor of agricultural engineering, Alabama Polytechnic Institute

Afternoon Program - 1:30 to 4:00

PRESIDENT ARTHUR HUNTINGTON presiding

1 SYMPOSIUM: "Engineering Phases of Land Use Planning"—Led by S. H. McCrory, chief, Bureau of Agricultural Engineering, U. S. Department of Agriculture

DISCUSSIONS:

(a) Mechanization—Leonard J. Fletcher, agricultural engineer, Caterpillar Tractor Company

(b) Electrification—E. A. White, director, Committee on the Relation of Electricity to Agriculture

(c) Structures—R. H. Driftmier, professor of agricultural engineering, University of Georgia

(d) Reclamation—E. R. Jones, professor of agricultural engineering, University of Wisconsin

(e) Management—D. H. Doane and C. H. Everett, Doane Agricultural Service

(f) Summary—J. B. Davidson, professor of agricultural engineering, Iowa State College

Annual Business Meeting—4:00 to 5:00

The A.S.A.E. Annual Dinner—7:00 to 9:00
Toastmaster (to be selected)

1 Presentation of the 1934 Cyrus Hall McCormick Medal

2 ADDRESS: (Speaker to be selected)

Third Day - Wed., June 20

Forenoon Programs (Two) - 9:00 to 11:30

(A) POWER AND MACHINERY DIVISION
ROY B. GRAY, chairman, presiding

1 PAPER: "The Technical Determination of Stress Surges in Loaded Wheels"—O. B. Zimmerman, consulting agricultural and mechanical engineer

2 SYMPOSIUM: "How the use of Farm Machinery Creates Employment"—Led by Theo Brown, experimental department, Deere and Company

DISCUSSIONS:

(a) R. U. Blasingame, agricultural engineer, Pennsylvania State College

(b) F. N. G. Kranick, J. I. Case Company

(c) F. W. Hawthorn, Monona County, Iowa, farmer

(B) RURAL STRUCTURES DIVISION
C. FRED MILLER, chairman, presiding

1 SYMPOSIUM: "What's Ahead in Farm Building Construction"—Led by Bernard L. Johnson, editor, American Builder and Building Age

2 PAPER: "Recent Developments in the Manufacture and Use of Lumber"—B. E. Gaylord, Weyerhaeuser Sales Company

3 PAPER: "New Ideas in the Construction of Low-Cost Concrete Floors"—W. G. Kaiser, agricultural engineer; manager, cement products bureau, Portland Cement Association

Afternoon Programs (Four) - 2:00 to 5:00

(A) POWER AND MACHINERY DIVISION
ROY B. GRAY, chairman, presiding

1 PAPER: "Ferrous Metals, Their Treatments and Properties for Agricultural Machinery"—H. Bornstein, testing and research laboratories, Deere & Co.

2 PAPER: "The Engineering Phases of Pest Control"—R. M. Merrill, agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture

3 PAPER: "Heating and Drying Milk Cans with Air" —R. L. Perry, agricultural engineer, University of California

4 Business session

(B) RURAL ELECTRIC DIVISION
RICHARD BOONSTRA, chairman, presiding

1 PAPER: "Electrical Equipment in Irrigation"—H. J. Gallagher, assistant professor of agricultural engineering, Michigan State College

2 PAPER: "Electrical Equipment in Soil Heating" — L. J. Smith, professor of agricultural engineering, State College of Washington

3 PAPER: "Research and New Applications in Farm Electrification"—Geo. A. Rietz, in charge of rural electrification, General Electric Company

4 PAPER: "Refrigeration in the Rural Territories of United States and Canada"—E. E. Bocock, commercial manager, Frigidaire Sales Corporation

5 Summary of Afternoon Program—Geo. W. Kable, Bureau of Agricultural Engineering, U. S. Department of Agriculture

6 Business session

(C) RURAL STRUCTURES DIVISION
WALTER G. WARD, vice-chairman, presiding

1 REPORT: "Farm Fence Materials Standardization"—H. W. Riley, professor of agricultural engineering, Cornell University

2 REPORT: "The National-Wide Farm Home Survey" —Wallace Ashby, chief, division of structures, Bureau of Agricultural Engineering, U. S. Department of Agriculture

3 PAPER: Farm Building Insulation"—G. D. Andrews, Celotex Company

4 Reports of Committees

5 Business session

(D) LAND RECLAMATION DIVISION
LEWIS A. JONES, vice-chairman, presiding

1 PAPER: "Work of the Federal Reclamation Service" —G. O. Sanford, chief, engineering division, Bureau of Reclamation, Department of the Interior

2 PAPER: "Development of Irrigation in Michigan"—O. E. Robey, agricultural engineer, Michigan State College

3 PAPER: "Use of Explosives in Sloping Gully Banks" —L. F. Livingston, manager, agricultural extension section, E. I. du Pont de Nemours and Company

4 PAPER: Program of the Soil Erosion Service"—B. P. Fleming, Soil Erosion Service, U. S. Department of the Interior

5 PAPER: "Latest Results of Engineering Experiments at Soil Erosion Control Stations"—C. E. Ramser, senior drainage engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture

6 PAPER: "Agricultural Engineering and the Marginal Land Problem—G. R. Boyd, assistant chief, Bureau of Agricultural Engineering, U. S. Department of Agriculture

7 Business session

Agricultural Engineering Digest

(Continued from page 173)

even for exceptionally large stables. Under normal winter weather conditions, a rate of air change of 50 cu ft per minute per animal unit (1,000 lb live weight) is sufficient.

The circulation of stable air is caused by the animals in it rather than by the ventilation system. Convection currents are stronger than the pull of the outtake flue, excepting within a radius of about 2.5 ft from the mouth of the flue. Rows of stanchioned cattle set up very definite and strong convection currents from animal to ceiling, to the nearest cold wall, to the floor, thence back to the animal. There is also present in litter alleys and feed alleys of considerable length another current lengthwise of the passage way in one direction along the floor and in the opposite direction along the ceiling.

Circulation in parts of stables given over to box stalls is usually much inferior to that among stanchioned stock. These sections of stables are usually colder and often given indications of sluggish air circulation. The remedy would appear to be to keep such sections well filled with stock and to pay particular attention to insulation of walls and ceilings, also to provide slots or holes for air circulation near the bottoms of box stall walls.

While concentration of outtake has no harmful effect, concentration of intake is not permissible. Intake flues must be well distributed around the stable, and a total intake area of 75 per cent of the outtake area appears satisfactory. In operation, all intakes should be kept open at all times except in cases where excessive wind pressure causes excessive intake velocities. Even then, they should not be entirely closed. Making covers of intake openings 1 in short is a good preventive.

The rate of air change through a stable should be controlled by regulation of the outtake aperture. The study showed that the rate of air change depends on the amount of air the outtake is allowed to handle. Air leakage through accidental openings in walls and ceilings will usually supply more air than the permissible rate of change in cold weather if the outtake capacity is not controlled. In many tests outtake velocities remained practically the same whether the intakes were open or closed. In multi-outtake systems, however, closing of all intakes caused backdrafting through one or more outtakes.

The place of intake flues is to bring about even distribution of incoming air and to prevent excessive intake velocities. Intake velocities should be so low that the incoming air will settle to the floor almost vertically as it unites with the down-flowing convection current. Stables without proper intake equipment are usually subject to serious drafts, due to the high velocity of air coming in under doors and other accidental openings.

Wet walls and ceilings, almost universally accepted as indicators of poor ventilation, can be prevented by more insulation more frequently than by increased ventilation. Filling spaces between studs with dry planer shavings or sheeting the inner surfaces of stable walls with commercial insulating board will not only prevent condensation on these areas but will improve the operation of the ventilation system.

Effect of Increasing Octane Number on Motor Fuel Performance, *W. V. Hanley*. Natl. Petrol. News, vol. 24 (1932), no. 38, pp. 27-32, figs. 4. Studies conducted at Oregon State College are reported, the results of which indicate that for any particular motor and operating conditions there is a definite octane number of fuel required for best performance, and that a loss of power will result above as well as below this value.

It is concluded that the most economical condition of operation would be obtained when using a fuel of high enough octane number to just remove detonation under the most severe conditions of operation that will be encountered with a particular motor, but no higher.

Some Experiments in Soil Heating, *J. E. Johansson*. Jour. Min. Agr. [Gt. Brit.], vol. 39 (1933), no. 12, pp. 1113-1116, pls. 2. Experiments conducted at the Alnarp Horticultural Institute are reported in which comparisons were made of artificial soil heating in frames with heating by fermenting the organic material in manure and straw, by steam in clay or wood pipes, and by hot water in copper and iron pipes.

The results of the experiments indicate that both the steam and hot water systems are useful in soil heating, and one or the other may be preferable under difficult conditions.

It was found that the fuel consumption was at least a third lower for the hot water system using copper pipes, but pump operation is necessary. In steaming, the temperature can be raised in a shorter time than by hot water circulation, but the boiler needs more attention when used for steaming than for heating water. It was also found that the steam system can be used for partial sterilization of the soil, as it is possible in a rather short time to raise the soil temperature to 70 deg C, and even higher when the steam is injected into the pipes by nozzles of greater interior diameter.

t

weather
animal

ls in it
ents are
a radius
achioned
ts from
nce back
ed alleys
passage
direction

usually
tions of
sluggish
uch sec-
insula-
for air

concen-
well dis-
cent of
intakes
excessive
en, they
openings

ontrolled
that the
uttake is
nings in
rmissible
not con-
cally the
i-outtake
drafting

bution of
Intake
le to the
convec-
usually
coming

s indica-
on more
between
rfaces of
only pre-
operation

OR FUEL
(1932),
tate Col-
ny parti-
e octane
a loss of

operation
ane num-
itions of
r, but no

on. Jour.
116, pls.
Institute
soil heat-
aterial in
d by hot

team and
the other

a third
ut pump
be raised
ler needs
water. It
al sterili-
to raise
the steam
ameter.